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OSTEOTOMY

OSTEOTOMY

WITH

AN INQUIRY INTO THE ÆTIOLOGY AND PATHOLOGY
OF KNOCK-KNEE, BOW-LEG,
AND OTHER OSSEOUS DEFORMITIES OF THE LOWER LIMBS

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OSTEOTOMY.

CHAPTER I.

THE ÆTIOLOGY OF GENU VALGUM, VARUM, AND OTHER OSSEOUS CURVATURES OF THE LOWER EXTREMITIES.

ORIGIN TRACED TO RICKETS—SYNONYMS OF RICKETS—QUESTION OF HEREDITY—STRUMA AND PHTHISIS DISTINCT FROM RICKETS—INFLUENCE OF MOTHER DURING UTERO-GESTATION—INFLUENCE OF EPIDEMIC DISEASES—INFLUENCE OF CHRONIC DISEASES—GROWING PAINS (?)—EFFECTS OF BAD HYGIENE AND BAD FOOD—WATER SUPPLY—INCIDENTAL OBSERVATIONS—RÉSUMÉ.

ORIGIN TRACED TO RICKETS.

In considering the various deformities constituting genu valgum, varum, and other curvatures of the bones coming under observation from idiopathic causes, the question arises whether they are to be regarded as the product of rickets, or whether they originate in a distinct disease, and if so, by what characters this distinct disease is known. It is plain, from the literature of rickets, that either the definition of this affection is too limited, or that there is a distinct disease also resulting in bone deformity. The latter view has been advanced,* though the discrimination between deformities resulting from rickets and those arising from this distinct disease has not been put forward in such a way as to carry conviction with it. It is described as a "simple weakness of bones and ligaments in which, without structural change, there ensue deviations of form and direction," and one would have supposed that the author, after giving this definition, would also have afforded particulars as to his reason for arriving at the conclusion that it constitutes a distinct disease. This, however, in his lectures, he does not condescend to do, and he does not advance any pathological facts in support of his allegation.

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* Holmes Coote, F.R.C.S.: "Lancet," March 9, 1861.

There is one point which militates against the assumption that rickets is the cause of genu valgum and varum adolescentium; that is, the statement made by many writers on rickets to the effect that it is a disease of childhood, some being more absolute than others in asserting that it never attacks the adolescent. If this were agreed to, then there would be a necessity for the recognition of a distinct disease or pathological condition, because there are a considerable number of cases in which deformities of the lower extremities, genu valgum and varum, commence during adolescent life. There are data, however, which prove that a condition comes on during adolescence, consisting in the exhibition of phenomena allied to those which Jenner classifies as rachitic, and when the modifications which age may be expected to make on the symptoms are taken into account, the phenomena bear a very close resemblance, if they are not, indeed, identical with infantile rickets. Thus, to take a case for the purpose of illustration. A lad who had been strong and healthy, who followed the occupation of clerk, took scarlet fever at the age of fifteen years. It was a severe attack, and was followed by bronchitis, from both of which he was much weakened but gradually recovered. A month after resuming his work he began to suffer from pains in his limbs, especially above the knees. From being an active lad he became listless, languid, and inclined to lie in bed instead of engaging in exercise. He had loss of appetite, slight looseness of bowels with fœtid stools. Often profuse perspirations about the head and neck, especially at night. He had to give up work about a fortnight after the commencement of these symptoms. The pains in his limbs were particularly severe when he attempted to walk, or even when he supported himself on his arms, so that he was glad to retain complete quiescence in the recumbent position. These symptoms greatly subsided within a month, under medical supervision; but he was left very weak and prostrate, and within the second month of the commencement of this illness his lower limbs began to curve outwards. The extremities of the bones of the forearm were swollen and painful to touch, as were also the distal extremities of the femora. His muscles were flabby; he had that exhausted look and earthy colour of skin which characterize rickets in a severe form. In six months after the beginning of the attack he had markedly developed bow-legs, having been compelled to seek employment three months previously, which necessitated much walking. Two other cases can be adduced, partly from personal observation, partly from data supplied by their medical attendant, the one commencing at twelve years, the other at eighteen years of age, both resulting in knock-knee, having previously exhibited a train of symptoms only referable to rickets. The patient, aged eighteen years, had a brother who was affected with rickets to a marked extent in childhood. Though these are the only three cases of rickets which can be spoken to definitely and personally, yet there are a number more which had symptoms attributable with a probability to rickets, and which ultimately assumed osseous curves. It would be easy to present many cases in which the osseous deformity arose during adolescence; but that would throw no light on their ætiology, which is the subject at present at issue, and therefore only those cases which have presented general constitutional symptoms have been adduced. There are, besides, not a few cases in which rickets has appeared during the earlier years of life, and which has continued from time to time during adolescence to exhibit constitutional symptoms, generally lessening in severity as the age of the patient advanced. It has been objected by some, that as rickets affects all the bones and produces an arrest of the osseous growth, if, therefore, all the bones are not affected, and if an arrest of growth does not take place in the adolescent, rickets could not have been the cause of the deformity. It must be remembered that age exercises a modifying influence, both in relation to the parts most affected, and also to the intensity of the action. One could scarcely expect that, though rickets did arrest the growth of the bone, the diminution in height would be great in a person who had almost reached his full height, or that the size of the face would be much out of proportion of the head for the same reason. Jenner met with a case at the age of nine years, and Mikulicz found, in a case of genu valgum adolescentium, the histological characters of rickets present in the end of the femoral diaphyses.

From such facts there can be no doubt that rickets does manifest itself during adolescence. There is, therefore, no *à priori* reason for considering that genu valgum, varum, and other osseous curves of the lower limbs, arise from any other than a rachitic condition. Under these circumstances, it is necessary to inquire into the relations of rickets to the above osseous deformities.

Rickets is a word supposed to be derived from the Saxon rick—a heap or hump.

Rachitis (*ῥαχῖτις-νόσος*—a spinal complaint).—This affection was so named from its having been supposed to depend on disease of the spinal marrow.

Rachitisme (*Fr.*).

Die Englische Krankheit is the name by which rickets is known all over Germany and Austria.

Doppelglieder, *Zwiewuchs.—Popular* German, double-joint or double-bones.

Rickets is one of the most widely-spread diseases incidental to large manufacturing communities, such as London, Manchester, Glasgow, and Lyons. Jenner describes it as very abundant among the London poor; Merei states that it is rife among the poorer classes of Manchester and Pesth; Delore says that no sooner is a hospital ward opened in Lyons for the reception of rickets than it is filled to overflowing; and in Glasgow it is very abundant.

IS RICKETS HEREDITARY?

Rickets is generally regarded as a non-hereditary disease, and while concurring in this view, if not taken too absolutely, there are a few facts which are considered worthy of note.

The father is stated to have no influence in the production of rickets, but in two cases which came under observation the father was rickety, the mother strong and well developed, while some of the offspring were rickety. In another instance, the father, who had been strong, took pneumonia, from which he made a tedious and imperfect recovery; and while still weak he was forced to take a sea voyage, on account of his health. During his convalescence from the pneumonia his wife became *enceinte*. She was a strong, well-developed woman, and had given birth to several well-formed children. This child was born at full time, but it was small, and had bent limbs. The practitioner who was present at the accouchement stated at the time of the birth that the child had knock-knees. The child, when grown up, was seen and operated on by me for marked knock-knee. There were no other circumstances expiscated which could account for this deformity. A family, several members of which were markedly rickety, came under the care of Dr. Allan, of Belvidere Fever Hospital. The mother, though weak, was well developed, and quite free from rachitic taint. The father was markedly rickety, and it was stated that rickety deformities were prevalent in his family for several generations. Again, a lad who was operated on for knock-knee, had an uncle who was affected with bow-leg, and several cousins who had deformed limbs. In two other cases, several cousins were deformed, besides several brothers and sisters of the patient operated on.

In one instance both parents were rickety, and they had one markedly rickety child.

There was one peculiar case, where three brothers became deformed in the lower limbs, each between seven and eight years of age; previous to this age they were perfectly straight, and each as he reached the seventh year of life, without any outward circumstance to bring about a debilitating state, began to show signs of weakness in the limbs, which began to curve. Though in this case there may have been external circumstances of a debilitating nature acting on these lads at that time, which were hidden from the observation of the parents, and though the particular age at which they began to act may have been a coincidence, still one cannot deny that there may have been a constitutional peculiarity at work here, which only manifested itself at this age.

These instances would tend to throw a doubt on the absolute non-heredity of rickets. It would be difficult to account for the rickety deformities in some of these cases except by admitting the hereditary influence. All the other cases, amounting to four or five hundred, point to the non-heredity of rickets. The exceptions in these instances, if they be admitted as such, would only prove the rule.

STRUMA AND PHTHISIS DISTINCT FROM RICKETS.

Assuming that rickets is non-hereditary, this fact makes a strong distinction between it and phthisis and struma, both of which are. It may be said here that there is no dubiety about the distinction of struma and rickets. Of all the cases which have come under observation, affected with knock-knee, bow-leg, or other curves of the bones of the lower leg, there was not one single instance which was strumous. Struma and rickets are stated to be sometimes found together, though I have not seen such a case. There can be no doubt about the coexistence of tubercle and rickets; as in one or two instances of rachitic deformity, the apices of the lungs were affected with tubercle. Rufz says that, in the examination of the bodies of twenty rickety children, tubercle was found in six.

THE INFLUENCE OF THE MOTHER DURING UTERO-GESTATION IN THE PRODUCTION OF RICKETS.

Though rickets is non-hereditary, the state of the mother during pregnancy has a very powerful influence on the formation of this disease. A woman in perfect health during utero-gestation will not, in all probability, produce rickety children, but one who is debilitated and exhausted during this period is apt to have rickets in her offspring. Observations innumerable verify this fact. It is seen that mothers who have large families have the first half or three-fourths healthy, well developed, and strong. They then begin to be exhausted from some cause, and the remainder of the family suffer from rickets, the disease here showing itself early in infancy. A frequent cause of this maternal exhaustion is prolonged lactation, or too frequent pregnancies, the mother never being allowed that rest which is necessary to restore her health before she is again pregnant. That rickets may arise from the condition of the mother, and that that condition may only be temporary, may be seen by the two following facts.

A lady had three strong and well-developed children; she then had a severe attack of pneumonia and other lung complications, from which she made a tedious convalescence, during which she became pregnant, the offspring being affected with rickets to a marked extent. Three years elapsed, during which she regained her former health and vigour. She again became pregnant, the result being a well-developed healthy child. In close scrutiny of the facts of this case, the only point of difference which could be elucidated was the weakness of the mother on the one hand, and her strength on the other. A second woman had the same number of children healthy and strong, when, during her fourth pregnancy, she took enteric fever and aborted. A fifth pregnancy ensued, dating from the second month after the enteric, and during the whole time of utero-gestation she remained weak and enfeebled. A child was born at full time, of small dimensions, who exhibited at eighteen months constitutional symptoms of rickets, followed at the end of two years by bow-legs, which increased as the child grew older. A sixth pregnancy took place before her strength was recruited, and this child also became the victim of rickets, though not to such a marked extent as the former. A period of over two years elapsed before she again became pregnant, during which she resided for the most part in the country, and had her health and strength greatly restored; she then became *enceinte* with her seventh child, which turned out a fine boy, free from rickets.

Of course the rule is, that once a woman gives birth to rachitic children, her health not being improved, the remainder of the offspring are all more or less affected.

So there can be little doubt but that the health of the mother during utero-gestation plays an important part in the production of rickets. This may be also seen, in some instances, where the parents are advanced in life before the birth of their children; such parents being often weak and enfeebled are apt to give birth to rickety offspring. It is generally those children that are last born in a large family that are affected with rickets. Out of 100 consecutive cases of genu valgum, or other curve of the lower limbs, 46 had one or more members of their family affected with curvature: 1 had three members (besides the patient) affected; 8 had two members each (besides patient), and 37 had one each (besides patient) affected with curvature. In most of these, the first members of the family that were born were free from rickets, and those that were affected came either last of all, or very near the end.

THE INFLUENCE OF EPIDEMIC DISEASES IN THE PRODUCTION OF RICKETS.

Suppose that the mother is well developed, healthy, and strong during utero-gestation, and the child is born well developed and quite free from rachitic taint, can such a child become rachitic from the force of external circumstances?

Though some deny the possibility of the disease arising *de novo*, the great bulk of evidence is in favour of the affirmative.

Observations tend to demonstrate two points: first, that children may be born with the rachitic stamp,—or diathysis, if you will,—yet there may be no development of rickets for a considerable period, often extending to years, at the end of which time it only ensues after the advent of some weakening disease, without which cause of weakness the rickets would not have obtruded itself. In the second place, healthy parents have given birth to children who have been strong and healthy, who have passed the first three or five years of their life free from the slightest suspicion of rickets, never having had a constitutional symptom or physical sign of the disease; when they have become affected with scarlet fever, measles, or other epidemic disease, from the results of which they have never completely recovered; they have been left weak, their muscles flabby, having occasional gastric disturbance, diarrhœa, and generally loss of appetite, accompanied with a tenderness to touch, occasional soreness of the bones, and a persistent languor. These have continued more or less constantly for months, when the distal extremities of the long bones have began to swell, notably the radius, ulna, tibia, and fibula, and finally changes in form have ensued in the spine or the pelvis, or most often in the bones of the lower extremities. Not only so, but the expression of face and the colour of the skin have, in many such cases, altered and assumed the peculiar appearance characteristic of rickets. The degree to which these phenomena reach depends on the severity of the attack. In many it is so mild that the subsequent yielding of the bones is the only point which remains on the patient's mind; in others, the constitutional attack forms the prominent part of the trouble.

Out of 100 consecutive cases of deformity of the lower limbs, in which the causation was minutely traced, forty-seven were the immediate sequence of epidemic diseases—measles, scarlet fever, typhus, enteric, whooping-cough, chicken-pox, and sometimes one or more of these following each other very closely. Judging from extended experience, the percentage found in the above is not too high. That district of the city of Glasgow in which epidemic diseases are most prevalent, is likewise the part in which rickety deformities are most abundant. Valuable testimony to the correctness of this view may be derived from an observation of Merei's, who, however, advances it in support of the idea that rickets and epidemic diseases arise under similar conditions, and not, as advanced here, that the one is the effect of the other. He says that in Pesth he has noticed that "chronic endemics and eruptive fevers exist in those places which are fertile in the production of rickets, and also in certain portions of Manchester having narrow, unclean, thickly-populated, badly-ventilated houses, where scarlatina had assumed a very destructive character, and where the children with rachitic symptoms were so commonly met with, as though this were the natural condition of infancy." No one will dispute the fact that rickets and epidemic diseases may be nurtured under similar conditions to those described by him; the same nidus would be suitable for the cultivation of both; but when one finds that rickets, in the great majority of instances, ensues immediately after these diseases have attacked the individual, and, on the other hand, that these diseases induce rickets when the habitat of the individual and surrounding circumstances are good, one cannot but interpret the evidence adduced as leading to the conclusion that rickets is often a sequel of epidemic disease.

It has been suggested that some of the practitioners who attended these cases of rickets following epidemic diseases, might have mistaken an acute attack of rickets for an epidemic disease. Admitting the possibility of this arising in a few cases, it could hardly obtain over such an extended area as that from which the patients coming under my observation have been drawn. Not more than a very few patients could have come from the same practitioner. This, however, may be set aside from evidence of another nature. In many instances the epidemic disease has been prevalent in the neighbourhood; it has attacked the whole family at the same time, the same symptoms presenting in each case, only being more severe in one or two members, these having a bad convalescence followed by rachitic symptoms. In a few cases the presence of the epidemic disease has been confirmed by reference to the experts in the fever hospital in which they had been treated.

It is also well to remember that in some cases in which the deformity of the limbs has not been preceded by marked symptoms of scarlet fever, measles, &c., such diseases may have actually been present in the persons' constitution, though not to such an extent as to compel them to go to bed or to seek medical aid. It is well known how scarlet fever and measles in mild forms pass almost unperceived over individuals, or are mistaken for a cold, or some slight derangement, until they declare themselves by their sequelæ. In some such cases dropsy ensues, demanding the attention of the physician, who, on inquiry regarding the antecedent feelings and sensations, is able to arrive at a probable cause of the dropsy in the shape of one of the prevalent epidemic diseases of youth. Diphtheria, in like manner, is said to come on so mildly, in certain instances, as to have its local manifestations mistaken for an ordinary sore throat, its true character only being recognized when paralysis of the pharyngeal or other muscles sets in. The bones, in like manner, may have their softness occasioned under similar circumstances. This may be advanced as one of the reasons why the bones of adolescents are much more commonly disturbed among the humbler classes than among their richer neighbours. The former are more constantly engaged, harder wrought; the parents not having that leisure to attend to their families that their more comfortable neighbours have, so that they do not pay heed to any but the more severe ailments. Even after suffering from scarlet fever or measles, their convalescence is not watched with that care which it requires; the patient is allowed to rise too soon, and is altogether badly attended to. This, of course, coupled with the want of good food and fresh air, makes rickets a frequent consequence.

THE INFLUENCE OF CHRONIC DISEASES IN THE PRODUCTION OF RICKETS.

Though epidemic diseases play such an important *rôle* in the induction of rickets, there are many other diseases which enfeeble the system and bring about the same result. Bronchitis, pneumonia, rheumatism, and such affections, provided they weaken the system sufficiently, and occur during the period of growth, are apt to induce rickets. Out of the 100 consecutive cases of deformed limbs previously spoken of, twenty-three originated after such diseases. Indeed, Portal and Pinel believed that rickets was symptomatic of "chronic maladies," and Broca states that most infants who die from chronic ailments present rachitic lesions in their skeletons.

GROWING PAINS (?).

In some cases where no special disease of an acute kind has preceded the formation of knock-knee and bow-leg, the individuals have yet complained, for longer or shorter periods, of pains in the bones, referable to various parts, but most often about the lower part of the thigh. Most of the patients ascribe them to "growing pains," some to rheumatism. These pains manifest themselves during the period of rapid growth, and are frequently confined to the lower part of the femur. If this be the seat of these pains, the time at which they manifest themselves is synchronous with the period when the growth of the femur, from its condyloid diaphysis, is most active, and when the layer of cartilage between the epiphysis and diaphysis is thickest. Any little weakness at that period might have the effect of increasing this layer without a sufficient development of osseous matter. It would be therefore weakened, and more liable to bend under pressure.

HOW INJURY CAN INDUCE RICKETS.

Injury is not rarely spoken of as inducing rachitic deformities; and it will be seen that if the injury is of a kind which will enfeeble the system there is no reason to doubt the validity of the statement. Out of 100 consecutive cases, eight were referred to as the sequents of injury, such as falls on the head, the wheel of a cart passing over the body, &c.

One such case came under my own observation. A fine healthy girl, of four years of age, belonging to parents in very comfortable circumstances, and having a family of three others, who were healthy and strong, fell on her head from a height of some feet, and received a severe bruise, with indentation of the skull. She was confused for some time, and exhibited symptoms of cerebral disturbance, from which she gradually recovered, and was thought to be quite convalescent at the end of a fortnight. A couple of months after she was again seen by me, as her parents thought she was not recovering her strength as they would like. The indentation in the skull had disappeared, but she had fallen off in flesh; was feeble, and easily fatigued.

She often perspired freely, especially when asleep. Instead of romping about, as she used to, she would sit on the floor, and say she was tired. The distal extremities of the radius and ulna were enlarged, and there was a slight development of knock-knee. No other cause than the injury could be traced for the formation of the rickets. Probably the shock to the nervous system acting on the *primæ viæ* had produced mal-nutrition, ending in rickets.

BAD HYGIENIC CONDITIONS AND THEIR EFFECT IN THE PRODUCTION OF RICKETS.

Besides these, bad hygienic conditions, the want of pure air, light, and sunshine, bad or scant food supply, all tend to produce rickets. M. J. Guerin experimented with young animals, chiefly dogs, placing them in a dark room, and feeding them on bread and beef. He found that they became rickety, the period of incubation being characterized by continuous diarrhœa, swelling of the belly, pain in movement, which was superseded by general swelling of the epiphyses, curves of the limbs, and difficulty of walking. Merei seems inclined to relegate the chief place in the ætiology of rickets to bad hygiene, especially to bad air. There can be no doubt that bad air has a powerful influence. Children reared in some parts of a city like Glasgow, confined to close houses or compelled to play in crowded streets, breathing, for the greater part of the year, air more or less filled with carbon and contaminated by the effluvia from sewers and emanations from chemical works; shut out from the light partly by the height of the houses, partly from the fact that even the sun's rays which do manage to struggle through the canopy of smoke which envelopes them, are so diluted that they are of comparatively little value; such children can scarcely be expected to be anything but feeble and liable to succumb to epidemics or to have severe sequelæ, leaving permanent effects.

That bad air is even more potent than scant food, may be adduced from the fact that there are many people living in the West Highlands of Scotland on very poor diet, poorer than what most of the poor classes in our towns have, and yet there seems to be little rickets among them. Although from most quarters in Scotland cases of distorted limbs have presented themselves for treatment, there has not been one from the West Highlands. The fresh air and the sea breezes appear to compensate for the lack of sufficient food.

WATER SUPPLY.

The purity of the water in Glasgow has been often spoken of as the cause of rickets, under the idea that it does not contain a sufficiency of earthy salts. On careful inquiry no data can be furnished to support the view that the Glasgow water supply has any effect in the production of rickets. Besides, Manchester, London, Lyons, Pesth, are not supplied by such water, and yet rickets is quite as abundant in these places. The idea may be put on a par with the statement that the rickets of London was in a great measure attributable to the alum which the London bakers employed to whiten the bread. There are some places where the water is very hard, such as the lime districts in the north of Ireland, and yet cases of rickets have come to me from these.

INCIDENTAL OBSERVATIONS.

There are one or two points which are interesting in this connection. Rickets may affect an individual to such an extent as to produce a slight degree of osseous deformity, which may remain stationary for years, not advancing and not decreasing. The patient may then become affected by some epidemic disease, after which the curvature in the limbs may become much more marked. This is by no means an unfrequent occurrence. There is one case in which a child became bow-legged when two years old, remained so till three, when the deformity gradually disappeared, and he was quite straight at the end of the fourth year. At five and a half years of age, he had a severe attack of measles, after which his knees began to go in, and ultimately he became knock-kneed, and was operated on for knock-knee some years later. It is interesting to note that when several members of a family are affected, they are not all curved alike: some are knock-kneed, some bow-legged or have anterior curves in the tibiæ. There was one family where all three curves were present in the several members: knock-knee in one, bow-leg in another, tibial curves in a third.

Those who recover from rickets without deformity, and who reach the period of full growth, do not afterwards become the subject of osseous deformity. Rickets does not appear to shorten the life of those who recover from its effects, as there is a skeleton in the University Museum of Bonn, of a man aged seventy-seven years, whose leg-bones are curved and expanded at their extremities; also the skeleton of a woman, aged ninety-four years, whose bones are curved from rickets.

Résumé.—It therefore may be concluded that, though in some few cases there is a probability that rickets originates from hereditary sources, still in the great mass of cases, the preponderating evidence shows it to be a non-hereditary disease. Secondly, it seems to be the result of mal-nutrition, or anything which interferes with the assimilative powers, and does so to a sufficient extent and for a sufficient length of time. Illness or weakness of the mother during utero-gestation has a great influence in producing rickets in the child. Epidemic diseases, acting on the individual during the period of growth, are the most powerful and the most frequent predisposing cause of rickets. Chronic ailments and bad hygienic conditions are also fruitful sources of this disease.

CHAPTER II.

AGE IN RELATION TO RACHITIC DEFORMITIES.

AGE AT WHICH RACHITIC DEFORMITIES APPEAR—THE EFFECTS OF RICKETS IN RELATION TO AGE—REASONS FOR CONSIDERING GENU VALGUM, VARUM, AND VARIOUS FEMORAL AND TIBIAL CURVES AS ORIGINATING IN RICKETS.

AGE AT WHICH OSSEOUS RACHITIC DEFORMITIES APPEAR.

Osseous deformities due to rickets may arise in utero, though they do so very rarely. Many writers on rickets deny the existence of this disease before birth. Glisson, in his statistics, finds none affected with rickets prior to birth. Out of 23,193 fœtuses born dead or left at the *Maternité*, Chaussier found two exhibiting rachitic deformities. In Guerin's table, three cases are mentioned as having occurred prior to birth. Mr. Stanley* mentions the fact that a fœtal skeleton exists in St. Bartholomew's Hospital Museum, showing a rachitic condition of the bones, accompanied by hydrocephalic enlargement of the skull. In one case which came under my care in after-life—nine years of age—the doctor who was present at the accouchement, the mother, and the mother's sister, all testified to the fact that the child's limbs were bent inwards at birth, the doctor remarking so before he handed the infant to the nurse. It had occasioned the mother great distress during the first year, and many things were tried during infancy to eradicate the evil. The child could not walk up till five years of age, and when seen by me he had markedly formed knock-knees.

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* Stanley: "On Bones"—Art. "Rickets," p. 217.

Rickets mostly abounds in early childhood, and it most frequently manifests itself between eighteen and thirty months. In the majority of instances, the deformity in the limbs commences from the time the child attempts to walk.

Spinal curvatures, twisted pelvises, thoracic deformities, and even bent limbs, may arise prior to this when the child can sit alone; but the majority of bent lower limbs date from the time the children have begun to walk. Two ætiological factors tend to make this period most prolific: the effect of the weakness of the mother during utero-gestation still being present in the child, for it is chiefly at this early period that rickets, having its seeds sown during fœtal life, appears; and epidemic influences, which have a powerful effect at this early age. Out of 100 consecutive cases of deformity of lower limbs, 43 appeared at three years or under; 29 from four to six years; 13 from seven to ten years; and 15 from ten to eighteen years.

In Guerin's table, out of 346 instances of rickets (not specially showing deformities in limb), 98 occurred during the first year, 111 during the second and third years, 29 during the fourth and fifth years, and 5 from the sixth to the twelfth years, 3 occurring before birth.

In Guerin's table, 5 cases of rickets have come on between six and twelve years, and in the table given above, out of 100 patients affected with rickety deformities in the limbs, 13 occurred between seven and ten years, and 15 occurred between ten and twenty years. The deformity in these latter patients came on during adolescence, and further experience shows that this is by no means uncommon. In such cases, though the most manifest signs of a constitutional condition being present is exhibited in the flabbiness of the muscles and in the deformities of the lower extremities, still the distal extremities of the radius and ulna are sometimes swollen beyond their normal dimensions, and in most the patient evinces an inaptitude for active muscular or other exertion. Three cases in which the constitutional symptoms have been marked have been already referred to.

In Mr. Shaw's admirable papers on rickets he contends, and with some reason, that those who have stated that rickets may come on at the age of puberty, have only mentioned the fact that the spine has been affected by rickets, whereas they omit to say whether the other bones in the skeleton were affected, and whether the individual presented any symptoms of rickets; the presence of these data being necessary to make their position tenable. But though those who have made this statement—among whom are Petit, Portal, Pouteau, Montfaucoln—do not condescend to particularize, it is not necessary that these particulars should be absent. Indeed, from a statement made in Shaw's criticisms, it would seem that there is in Portal's work, "Sur le Rachitisme," a passing mention of pelvic deformities occurring along with rickety vertebræ in the adolescent. He also admits that Wilson, who espouses the view that rickets may come on about puberty, warns surgeons of the dangers to which the bones of the spine, chest, and pelvis are exposed while wearing cumbrous instruments of support.

Mr. Shaw further asserts that, "As it is familiar to every person, neither the bones of the upper nor those of the lower extremities become incurvated when the disease commences near the age of puberty, it follows that a cause totally different from rickets gives rise to it, and that the pelvis incurs no danger in being implicated in this kind of deformity." * This statement is easily controverted by the fact that very numerous instances of knock-knee or bow-leg occur during and after the advent of puberty.

Velpeau gets out of the difficulty which thus seemed to present itself, by ascribing the pelvic deformities which arose about the period of puberty, to a disease which he names *osteo malaxie*, but which he does not define or differentiate from rickets, and which produces the very same changes in the bones. From these facts it is seen that many authors believed in the existence of a disease which they held to be rickets, which came on about the age of puberty; and though, in some measure, they may have used the term loosely, it is scarcely likely that such a number of them would have used the term and regarded these deformities as rachitic without some elements of truth being present. But Mr. Shaw's tests for the presence of rickets in the adolescent have been fully complied with in the three cases which have been detailed, and which have come under personal observation; and also from the fifteen cases which are mentioned of deformity of the lower limbs, coming on from ten to eighteen years. Finally, Mikulicz has found the histological character of rickets in the distal extremity of a femur, taken from a knock-kneed patient sixteen years of age.

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* Mr. Shaw: "On the Conformation of the Skeleton in Rickets," "Med.-Chir. Trans." xvii. p. 439. Mr. Shaw quotes from Velpeau: "Traité Élém. de l'Art des Accouchement," i. 53.

From these facts it is apparent that rickets is a disease incidental to the whole period of growth; it is rarely congenital, occurs most frequently in the child from eighteen months to thirty months, getting less common as the age advances, but occurring in about 15 per cent. of the cases during adolescence.

THE EFFECT OF RICKETS IN RELATION TO AGE.

The effects which rickets produces vary according to the age at which it acts. The younger the patient the greater the intensity of the disease, other things being equal. Those cases which have a uterine origin, and those which are attacked by rickets during the first two or three years of life, are generally those which are most powerfully affected, the whole of the bones of the skeleton being more or less involved; and not only are they liable to distortion, but in severe cases they are arrested in growth. To this arrest of growth the small size of the face, comparatively with the head, and the stunted lower limbs, are attributable; Shaw believing that the face and lower limbs are comparatively retarded in growth during fœtal life, and that they have a commensurate activity after birth; but when their growth is arrested by rickets at this period, the characteristic appearances ensue.

Cranio-tabes is said to be one of the earliest manifestations of rickets, and appears in children three or four months old. The beading of the ribs—the rickety rosary—is a very common early indication of rickets. These are seldom found after the third year. Affections of the other bones have a more extended time-range; the spine, pelvis, radius, and ulna, are often affected early, but they may become distorted up to adolescent life.

Regarding the lower limbs, with which our duty chiefly lies, it may be said that anterior tibial curves are confined to the earlier years of life. So, likewise, are the anterior femoral curves, few of them arising after the third year. Those cases of twisting of the bones of the lower limbs are all incidental to the first four years of life. Once these curves have formed, they may, and often do, increase in after-life, but their initial formation is confined to the first two or three years. Genu valgum and varum have a much more extended age period—from the first year up to the eighteenth year. The earlier they are developed, the more apt are they to be complicated with other curves, such as anterior femoral and tibial curves, and twists of these bones. Knock-knee and bow-leg occurring after the sixth year are generally uncomplicated. In looking at a case of knock-knee, if one finds that there are a number of subsidiary curves, it will almost certainly be found that it was produced during the first three or four years of life. The earlier the rickets comes on, the more likely are the limbs to be stunted, so that in cases of knock-knee there may be an actual shortening of the limbs, besides the apparent one owing to the angle formed. When rickets does act late in life, it attacks the epiphyseal ends of the femur more frequently than the shafts, though the latter are sometimes affected. The epiphysis of the condyloid portion of the femur is not united to the diaphysis until eighteen to twenty years of age, and as it is still growing it is more liable to be attacked. When knock-knee has been developed during adolescence, the bones, having so far completed their size, can scarcely exhibit much abnormal shortening, even supposing the disease was so intense as to produce arrest of growth.

Knock-knee, or bow-leg, or anterior curves of the femur or tibia, have not, as far as is known, occurred after the period of adolescence.

REASONS FOR CONSIDERING THE OSSEOUS DEFORMITIES OF THE LOWER EXTREMITIES—KNOCK-KNEES, BOW-LEGS, AND VARIOUS FEMORAL AND TIBIAL CURVES—AS ORIGINATING IN RICKETS.

I.—Their ætiology is identical—some cause of severe and prolonged debility.

II.—Rickets and those osseous deformities abound in the same habitat.

III.—The period of life during which these deformities occur is limited, and is identical with the period during which rickets attacks the body—the period of growth.

IV.—Deformities which are physically identical with those above-mentioned arise from rickets, and in the few cases examined the histological characters are the same.

CHAPTER III.

A FEW POINTS IN THE PATHOLOGY OF RICKETS IN RELATION TO THE CHANGES IN THE BONES—VIEWED FROM A SURGICAL ASPECT.

Rickets may be described as a peculiar condition of the system, incidental to the period of growth, which manifests itself by many symptoms, one of which shows itself in the bones. Some of the constitutional symptoms precede the manifestation of the bone affection, many of them arise from weakness, and are such as accompany debilitating diseases generally. These are combined with hypertrophy of the glandular system (liver, spleen, &c.), a spare muscular development, a flabby condition of the muscular fibre, and a peculiar aspect which is recognized as belonging to the "rickety diathesis." The constitutional symptoms and appearances of rickets are excellently given by Jenner* in his monograph, and as the osseous deformities arising from rickets are the points which chiefly concern us, the reader is referred to Jenner's article for the other aspects of the disease. While keeping the general aspects of the disease before the mind, attention is specially directed to the flabby muscular system and the state of the bones.

The axiom that the phenomena of disease are similar to those of normal life is nowhere better illustrated than in the pathology of rickety bones. An excessive preparation for ossification, with an arrest in the completion of the process, is the character of the osseous manifestation of rickets. There is no new formation, but "merely a change in the quantity and arrangement of normal structures and secretions." Rindfleisch describes rickets as a morbid acceleration of those changes which usher in and prepare the way for the transformation of cartilage into bone, and the development of bone from periosteum. The actual ossification follows at a slower pace, and hence, the substance which in the normal course of development undergoes immediate conversion into bone tissue, and whose existence is therefore of a very brief and temporary character, accumulates in disproportionate quantity. Now it is this intermediate substance which forms the swelling of the bones and allows them to be bent and broken. "In normal bones the proliferating zone of cartilage can barely be detected by the naked eye, as an extremely narrow reddish-grey stripe; in rickety bone it forms a broad, grey, and translucent, very soft cushion between the cartilage on the one hand and the perfect bone tissue on the other." This appearance, described by Rindfleisch, is seen in a specimen of genu valgum at present in my possession. A somewhat similar condition is described by Mikulicz, and figured by him in Langenbeck's "Archiv."

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* A series of three lectures on "Rickets," by William Jenner, M.D., December, 1859. "Med. Times and Gazette," March, 1860, pp. 259. 333. 415, 465.

Then follows an explanation of how the shafts of the bones become involved.* "The disturbance of the periosteal growth is chiefly to blame for the manifold curvatures and infractions to which the bones of the extremities are exposed. The deposit of new matter on the surface of the bone is attended by a compensating absorption of compact osseous tissue from the layers bounding the medulla, an absorption exactly proportionate to its application. This takes place in bones under ordinary circumstances, and does so also in rickets. Hence the loss of compact tissue, and the substitution of soft layers externally, permitting the bone to yield, bend, or break." It is also important to note the manner in which Rindfleisch describes the fracture in rickets. "Hence the bones bend, or, what is just as common, they break on one side only, like a roll of paper, while the other side is simply stretched across the seat of fracture, and the central marrow is crushed" (willow fracture—green stick fracture).

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* "A Manual of Pathological Anatomy," by Rindfleisch. Bonn.

There are three other points worthy of note. First, that rickets sometimes affects one part of the skeleton to a marked degree, while the other parts are very slightly affected. Second, the bones may be affected in all degrees, from a condition in which the departure from the normal is so slight, that one would hesitate in pronouncing it rickets, to those where the rickety appearances are extremely pronounced. In support of the former statement, Rokitansky says that rickets is sometimes prominently marked in one part of the skeleton, while the rest of the bones are slightly affected. In confirmation of the latter, Jenner says: "We see all degrees of softening. . . . all degrees of enlargement . . . of the long bones, from that where we might maintain the enlargement was that only proper to the child, to that in which the enlargement of the wrist would strike the most casual observer." In the third place, the degree of softening of the bones does not bear any corresponding relation to the enlargement at the ends of the bones. Jenner states that, if the attack be attended with severe general symptoms, the softening of the bone usually precedes and is out of proportion, for some time at least, to the enlargement of the ends of the bones.

Passing over the more minute changes, it is necessary to note that when rickets becomes arrested, calcareous nuclei begin to appear, to enlarge, and to unite with one another. These osseous layers accumulate and acquire a very compact, hard consistence, often much more hard and more dense than normal; sometimes likened to ivory. The process of repair has been said to resemble the calcification of callus in cases of fracture. Even in children, the bones sometimes assume great hardness at this stage.

This is what is termed by the French *éburnation*, the former stage being known as *ramollissement.*

Résumé.—The bones in rickets may be affected in two ways—by softening of their shafts, and by an accumulation of soft cartilaginous tissue at their extremities. These two are in no way proportionate to one another; in some cases the softening of the shafts, in others the deposit of tissue at the extremities of the bones, predominates. These pathological conditions are of all degrees, from that in which it is difficult to say that the disease exists, to that in which it is most markedly pronounced. When the disease is arrested it is followed by a calcareous deposit, which produces great hardness and density of the bone.

CHAPTER IV.

THE FORMATION OF THE OSSEOUS CURVES.

CAUSE OF THE INITIAL FORMATION OF OSSEOUS DEFORMITIES IN THE LOWER LIMBS—CAUSE DETERMINING THE SPECIAL DEFORMITY—SECONDARY FORMATION ATTENDING THE CURVES.

CAUSE OF THE INITIAL FORMATION OF OSSEOUS DEFORMITIES IN THE LOWER LIMBS.

Rickets being the common predisposing cause of these deformities in the bones, what is the element, or what are the elements, determining the deformity? Rickets produces a change in the consistence of the bones or their extremities, what is the exciting cause of the bending?

Various theories have been propounded to account for the formation of these deformities. One of the most generally accepted is that of muscular action. Thus, anterior tibial curves were supposed to originate by contraction of the tendo-achillis; knock-knee, as the result of contraction of the biceps; the bend sometimes met with in the humerus at the insertion of the deltoid, as the result of the strong action of that muscle. On the other hand, paralysis of certain muscles, relaxation and contraction of the ligaments, have also been brought forward to account for the various deformities.

If the premise be granted that these deformities are due to rickets, then there is the clear presence of muscular weakness and flabbiness of the muscular fibre, which at once removes the element of powerful muscular contraction from the field. Even supposing it be denied that rickets is the origin of these deformities, it has yet to be proved that muscular contraction plays any part in their production. As far as personal experience in this kind of deformity goes, there has not been a single instance originating from excessive muscular development or powerful muscular contraction. It is probable that the surgeons who have advanced these opinions have argued from the fact that, when they have seen well-developed genu valgum, for instance, they have also found the tendon of the biceps so very tense that the deformity could not be relieved without cutting it; but this ought to be regarded as the result, and not the cause of knock-knee. If these bendings were due to muscular contractions, why would such muscular contractions confine themselves almost entirely to the lower extremities—as such osseous malformations of the upper extremity are rare, in comparison to those of the lower? I have only met with three instances of osseous curvature of the bones of the upper extremity:—One lad, who had the radius and ulna of both arms bent at their lower thirds, his mother attributing it to his "creeping," as he was long of walking. A second boy, who had his left humerus bent at an obtuse angle at the insertion of the deltoid, the nurse stating that she had to lift him by this arm, when crossing the streets. As she carried another child on her left arm, she lifted this boy by his left arm in her right; this had been done several times a day, for over six months, when she noticed the deformity. In this instance there were none of the other bones deformed. The third case was a boy who ran on all-fours, like a monkey, and he had his right forearm bent inwards at its lower third. The lower third of the arm was covered by thickened skin, occasioned by his placing this part of the forearm on the floor, as he crept along, while he kept his hand shut, as if holding something in it. The finger-tips only of the left hand touched the floor, so that most of his weight was sustained by his right arm, while the left served to maintain the balance. In none of these cases of deformity of the upper arm was muscular action found to be the cause of the deformity, it being traceable to the weight of the body. Besides, muscular action, even suppose it were granted to produce some of the osseous deformities, could only account partly for these; and in many others the curves are such that a glance at the mechanics of the special muscular action involved is sufficient to put it out of consideration. This question then presents itself: the bones of the upper and lower extremities being equally affected with rachitic softening (as is evinced in the great frequency of the enlargement of the distal extremities of radius and ulna, and their very frequent fracture while in this condition), what is it that acts on the bones of the lower extremities, inducing deformities, which does not equally act on the bones of the upper? The factor which pertains to the lower limbs out of all proportion to those of the upper is the *weight of the body.*

This is supported by, first, a study of the mechanism of the deformities; secondly, by the fact that those children who are confined to bed during the acute stage of rickets, and in whom the weight of the body is thereafter carefully prevented from being thrown on the lower limbs until the bones are firm, are not the subjects of those curves; and thirdly, those persons whose occupation compels the weight of the body to be thrown for long periods on the lower limbs, are fruitful in producing such deformities, so much so that, the German vernacular for knock-knee is "Backerbein."

Jenner also takes this view. Thus he attributes the weight of the arm as the cause of the bending of the humerus at the insertion of the deltoid; the curve of the clavicle to the pressure of the arm in supporting the weight of the body, &c.

CAUSE DETERMINING THE SPECIAL DEFORMITY.

Rickets being the predisposing cause, the weight of the body the exciting cause, what is it that determines in one case genu valgum, in another genu varum, in a third tibial curves and other varieties of bent limbs?

These depend on a variety of circumstances, among which there is the degree of intensity with which rickets acts; the particular portion of the bone which is most affected; the age of the person at the period of attack, with reference to the development of the skeleton, the parts which are growing most actively being the ones first attacked, and these in the adolescent are generally the epiphyses.

The more intense the action and the younger the patient is when attacked, the greater will the number of curves be. The tibial curves belong to the first two or three years of life, few or none originating after three years, though when once began they may increase in latter years. Though bow-leg does originate frequently during adolescence, it is by no means so common at that period as knock-knee.

If the shafts of the long bones are more implicated than their extremities, one would expect bow-leg and not knock-knee to be formed; if, on the other hand, the distal extremity of the femur were most affected, and the shafts little, genu valgum would be the result; and in this case the theory is borne out by the pathology of bow-leg and knock-knee.

There are the various spinal malformations and pelvic deformities, which when once formed and fixed, would act on the lower limbs and tend to produce irregularities of shape.

Pelvic deformities do play an important part in the development of knock-knee and bow-leg. Given a twisted pelvis, one side being high, the other low (as in Fig. 1), the latter would almost necessarily throw the limb of that side in, while the limb on the high side would be inclined outward. Four or five cases where this pelvic deformity was found had their lower limbs disposed in this way. The particular form of the femoral neck in relation to the trochanter would play a part in the production of these deformities, according as it was oblique, transverse, or whether the trochanter was raised above the level of the head. It is, of course, clear that genu valgum and varum, once produced, might react on the above parts and induce, or help to induce, the above deformities of spine, pelvis, and femoral neck. That is to say, the one would act on the other, and therefore in the individual it is a question as to which arose first.

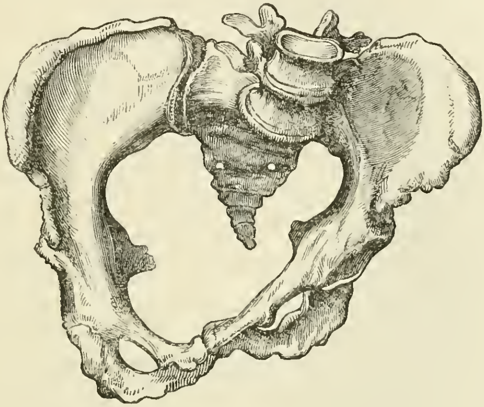

Fig. 1.—Pelvic Deformity, affecting Form of Lower Limbs.

External circumstances provide powerful influencing causes. The particular manner in which the weight of the body is directed on the bones; whether the child creeps, sits, shuffles along the floor, stands, or walks, each has its effect. The manner in which the child is carried by the nurse is often spoken of as likely to induce certain deformities. In this way the combination of genu valgum and varum is stated to arise from the child being always carried on one arm; the limb next the nurse's body being bent outwards, the other inwards. While not denying the possibility of this mode of producing the deformity in some very exceptional case, it has not been found to be the cause in any of my cases. That this deformity does arise otherwise, is established by the fact that many of these deformities commence after the patient has reached an age when carrying in the arms is out of the question. In one case it originated at fifteen years, occurring after a severe attack of scarlet fever; in another at twelve years, after a severe illness.

SECONDARY FORMATIONS OCCURRING IN LIMBS PREVIOUSLY DEFORMED.

Whatever be the initial cause of these osseous deformities in the lower limb, once they are formed, the conditions remaining the same, they go on increasing until walking becomes impossible, or, what is more fortunate, the individual gains strength, the bones become hard and offer sufficient resistance to the bending force to stop its further progress. If the strength of the individual improves and he is permitted to take things easy, not allowed to stand or walk too much, the deformity will not be progressive. If during adolescence any fresh cause of weakness arises, months or years after the arrest of the progress of the deformity, the deformity again advances. It is quite common to hear that a given patient was knock-kneed to a slight extent, at a certain age, when the deformity ceased to advance, and the limbs even seemed to grow a little straighter—some years later the patient took fever, after which the deformity became greatly aggravated; or that a bow-legged case was not marked until he was sent to some occupation, which compelled him to stand, walk, or carry heavy weights, for ten or twelve hours daily, without being able to get regular meals.

Besides the initial deformity, there is, through time, a tendency to the deposition of bone in abnormal situations, and also a tendency for the affected bones to somewhat modify their shape. These secondary formations occur most often, and to the greatest extent, among those who have been affected during early years. This is, perhaps, most commonly met with in cases of knock-knee, where, in some instances, one finds a new formation of bone on the inner side of the knee, commencing at the extremity of the femoral diaphysis, running through the epiphysis to the upper portion of the diaphysis of the tibia. This new formation often assumes the aspect of a ridge, running parallel with the axis of the limb; sometimes forming a sharp edge on the inner side, and ending abruptly in those tibial spines so often noted. In some cases, this forms a perfect osseous buttress; in others, there is a flattening of the bone from before backwards on the inner aspect of the limb. The peculiarities of these formations will be treated of further on. In bow-legs, these spines are rare, yet they do sometimes occur on the outside of the limb, at the point or points of greatest convexity. These secondary formations are generally found at the points of greatest weakness, or towards the apex of the angle; and from the appearance they present, one might suspect that Nature was making an attempt to remedy the deformity, by running a new osseous formation in a line with the axis of the trunk. Then there is the fresh accumulation of osseous matter on the side of the bone which is weakest—the concavity. This fact was first pointed out by Stanley regarding anterior tibial curves, but it holds good in most deformities which are made up of curves—the concavity becoming the most dense. This is well seen in the section of the femur affected with genu valgum (Fig. 51).

These are merely illustrations of the fact, that many of the formations which are found in a given case of osseous deformity, may be secondary in their production.

CHAPTER V.

GENU VALGUM.

SYNONYMS OF GENU VALGUM—DESCRIPTION OF GENU VALGUM—THEORIES REGARDING THE FORMATION OF GENU VALGUM—PATHOLOGICAL ANATOMY OF KNOCK-KNEE—INTERNAL CURVES AT LOWER THIRD OF FEMUR—ELONGATION OF INTERNAL CONDYLE—INWARD INCREASE OF INTERNAL CONDYLE—THE PART PLAYED BY THE TIBIA IN THE FORMATION OF KNOCK-KNEE—TIBIAL SPINES—RÉSUMÉ.

Genu Valgum, Genu Introrsum, Esogonyaneon—Knock-knee, In-knee—Genou en didans, genou cagneux—Knickbein, Baekerbein, X-Bein, Schemmelbein, Ziegenbein, Kniebohrer, Knieeng.

DESCRIPTION OF GENU VALGUM.

In the normal limb, a line drawn from the head of the femur to the middle of the ankle-joint passes through the centre of the knee-joint; in knock-knee the middle of the knee-joint is thrown to the inner side of this line. Inward deviations of the knee are extremely variable in extent, some being barely recognizable, while others have the lower limb placed at a few degrees less than a right angle to the normal femoral axis. The ankle, in well-marked cases of knock-knee, forms an outward convexity; the foot is well arched, the instep high, the patient walking principally on the outside of the foot. When the foot is nude, and the patient walks, the extensor and flexor muscles are seen to be brought well into action, and the toes seem to grasp the floor, in endeavouring to maintain the equilibrium, to support the knee, and prevent its yielding further inward under the weight of the body. Most surgeons and writers on the subject of knock-knee state that flat-foot accompanies knock-knee. This statement, most likely, ensued from preconception, and not from extended observation. At the outset of this affection there is a tendency for flat-foot to form, and it actually does take place when the whole muscular system is lowered. In such cases, however, the patient walks with difficulty, or probably not at all. As the patient gains strength, the knock-knee continuing, the ankle and foot assume the typical form. If flat-foot did pertain to knock-knee, the foot would have little hold on the ground; it would be liable to slip sideways. In order to prevent this slipping, the muscles of the leg and foot exert themselves, an attempt is made to grasp the floor, with the result of causing the outside of the foot to come to the ground, and the instep to be made higher. The boot worn by a typical knock-kneed person is twisted inwards, the convexity corresponding to the ankle, being toward the outer side; the outer aspect of the heel is always worn more than the inner. So characteristic is the appearance of the boot that this affection can almost be diagnosed from the shape of that article, when it has been worn for some time.

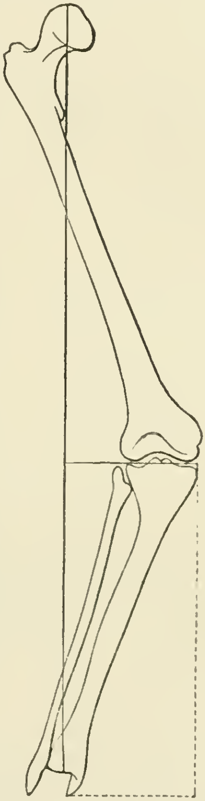

FIG. 2.—SCHEMATIZED DRAWING OF GENU VALGUM.

In aggravated cases of knock-knee, the lower limb is set at such an angle to the femoral axis that one would consider it impossible for the patients either to stand or walk; and this would in reality be the case if these patients stood straight. This, however, they do not do. They assume more or less of a crouching attitude; the tibiæ are placed well behind the femoral condyles, instead of directly in a line with the axis of the limb, and the femora are somewhat flexed on the abdomen. The lower limbs being placed well to the rear of the condyles, they do not participate in the inequality which the distal extremities of the condyles assume. In this way patients are enabled to walk who could not otherwise do so. Even in the most aggravated cases of knock-knee, when the lower limbs form an angle of 62-15 with the femoral axis, they may be brought parallel to the thighs by flexing them completely. That is to say, that in the position of complete flexion, the deformity is obliterated. It is only in positions of more or less extension that the deformity exists; and it is most marked in complete extension.

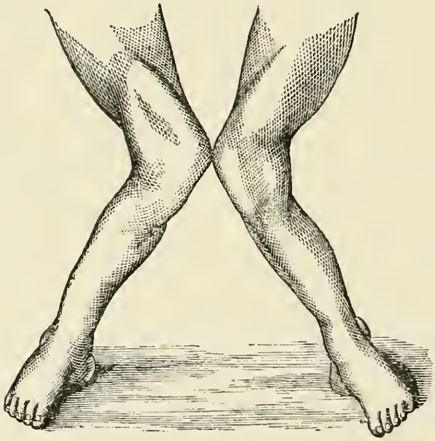

Fig. 3.—Typical Case of Genu Valgum.

The gait of knock-kneed persons is very variable. The most common mode of standing, in aggravated cases, is with one limb partly folded on the other (Fig. 4), the one knee looking out from behind the other; and when the person walks there is rather a distressing see-saw movement, the one knee going in and out alternately with the other.

In all markedly developed cases of knock-knee, the patella is more or less thrown to the outside of the limb, toward, or on, the external condyle. In many instances it covers the external condyle, and in some it slides during flexion to the outside of the condyle. In these latter cases, the anterior surfaces of the condyles, with the intercondyloid notch, are exposed, and can be easily seen or felt beneath the skin.

In the schematized drawing of the bones in genu valgum Fig. 2), the dotted lines indicate the lower angle formed. This affords a tolerably accurate idea of the amount of the deformity. Many attempt to estimate the degree of the deformity by the distance which the internal malleolus is from the middle line, but this only gives half of the data required. It is necessary to give the vertical length existing between the tip of the internal condyle and a point opposite to the tip of the internal malleolus. In this way the angle is estimated. Fig. 3 is a woodcut taken from casts of the limbs of a patient affected with genu valgum. The internal femoral curve is observed through the soft parts in the lower third of the thigh. The knees meet at the distal extremities of the internal condyle, and from that point a ridge runs downwards on the tibia, ending abruptly at the tibial spines. The insteps of the feet are high, the toes being turned somewhat inwards.

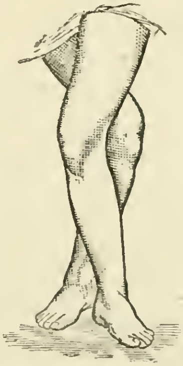

Fig. 4. — Standing Posture of a Knock - kneed Patient.

THEORIES REGARDING THE FORMATION OF GENU VALGUM.

It has been seen that many believe the osseous deformities found in the lower extremity to be due to excessive muscular action in a particular direction. In accordance with this view, Jörg attributes genu valgum and varum to contractions of certain muscles. Duchenne believes that knock-knee is produced by the preponderating action of the femoral biceps over the muscles of the *patte d'oie.* The fact that the biceps is supplied with the same nerve as the inner hamstrings would militate against this idea. J. Guerin and Billroth believed knock-knee to be due to a fibrous retraction of the external lateral ligament, and a shortening of the biceps and fascia lata. It is more than probable that these gentlemen have deduced their theories from the fact that these structures are shortened in marked knock-knee, and that they have mistaken the effect for the cause. Besides, these theories require for their maintenance the existence of an increased muscular or fibrous action, which is scarcely tenable in the face of the enfeeblement of the whole muscular system, which takes place at the outset, and as one of the characteristics of this disease.

A much more feasible hypothesis, and one to which Malgaigne, Stroymer, and many other surgeons have subscribed, attributes knock-knee to a peculiar relaxation of the internal lateral ligament, this being afterwards followed by an outward inclination of the leg, and an hypertrophy of the internal condyle. The difficulty here is to ascribe a reason for the internal lateral ligament being relaxed more than the other ligaments of the joint, the cause of the weakness being general, and the further difficulty of its being supported by no actual pathological facts.

There are other theories which regard the deviation as due to changes in certain portions of the distal extremity of the femur. Tripier believes that there is an arrest of development in the external condyle produced by mechanical means. Gosselin and others state that there is premature union of the external half of the epiphysis, while others state that there is hypertrophy of the internal condyle, followed by a nutritive activity of the epiphysary cartilage; while Marchand and Terillon believe that knock-knee is due to a true softening of the epiphysary cartilage, which becomes twisted by prolonged malposition. Finally, Mikulicz thinks that the deformity lies in the distal portion of the femoral diaphysis. The latter has the advantage of being based on the examination of a number of specimens, strengthened by some clinical observations.

The first group of theorists, who regard the malformation as osseous, seek to explain what they considered as the elongation of the internal condyle; the latter, including Marchand, Terillon, and Mikulicz, seek for the deformity in or above the epiphysis.

In the investigations which have been made by the writer, the predisposing cause in the great majority of instances, a majority quite sufficient to make it a rule, was rickets, as has already been pointed out. It was also seen that rickets, though affecting the whole system, acted unequally on the skeleton; at times being most marked at the extremities of the long bones, at others affecting their whole shafts. In this was found a determining cause for the various deformities, the weight of the body being the exciting cause in each. Thus it was seen that, in genu valgum, the distal extremities of the femora were most markedly affected, being enlarged and softened, hence the yielding at that part; and as the inner side of the distal extremity of the femoral shaft was thinnest, one would expect the yielding to take an inward curve at this point. The histology of rickets has already been alluded to, it only remains to add that in one specimen of genu valgum adolescentium, already referred to, the pathology pointed distinctly to rickets, there being an increase in the proliferating zone of cartilage between the diaphysis and the condyloid epiphysis of a similar histological character to that met with in rickety bones. Rickets may be taken, then, as the cause of the softening of the bones; the weight of the body as the factor producing the deformity. The next point to be determined is the pathological anatomy.

PATHOLOGICAL ANATOMY OF KNOCK-KNEE.

In studying the pathology of genu valgum, it was apparent that that affection could not be accounted for by a single factor; that the cases differed very greatly; that what would constitute the pathological expression in one would not be the truth as regards the other. After having had over 100 cases of genu valgum under observation, the general impression which their pathological condition conveyed, pointed to certain conclusions, but before formulating these it was considered advisable to take more minute measurements and observations than hitherto, and to arrange them according to a definite plan.

The patients were taken consecutively; every one that entered the ward was measured, there being no choice in any case. The patient was laid on a level surface on his back, his limbs were placed at full extension, and the measurements taken. The first point measured was from the anterior superior spinous process to the level of heel. The two angles which the limb formed were taken. A perpendicular line to the axis of the trunk, drawn from the tip of the internal condyle to the level of the tip of internal malleolus; a second line drawn transversely to the axis of the trunk from the tip of the internal malleolus to the point where it bisects the former line; the third side being added. The outer angle was measured by taking the distance from the tip of the external condyle to a line drawn from the trochanter-major to the tip of the external malleolus. Reference to the schematized woodcut, Fig. 2, shows this: the dotted lines represent the lower angle. Then the length of the condyles was taken, the internal being measured from the spine for the insertion of the adductor magnus tendon, which is easily felt in the healthy limb, while it is markedly developed in most cases of knock-knee. The knee was then flexed and the measurement taken in the axis of the femur, from the spine to the lowest point of the articular surface of the condyle. The points in the external condyle were the prominence immediately above the popliteal groove, which is sufficiently easily made out, to the lowest point in the articular surface of the condyle, measuring in a line with the long axis of the femur. The measurements were taken by calipers, so that the length was alone noted, without taking into account the inward or outward deviations which the condyles might assume.

The femoral curves were then noted. The relative measurements of the inner and outer side of the head of the tibia were not so satisfactorily made out for want of fixed points. The lowest point of the anterior tuberosity was made out and the measurement taken from it to the posterior inner and outer borders, respectively, of the articular surface of the tibia. In this way, the relative difference in the size of the tibial head was ascertained. The curves of the tibia and the position of the spines on its inner side were noted. The position of the patella was also marked. These data were very carefully gathered in 100 patients who had 166 limbs affected with knock-knee. Each limb was examined and measured separately, as in many instances the deformity was greater in one limb than in the other. It would occupy too much space, and be of little object, to give these tables in detail; the results merely are referred to.

INTERNAL CURVES AT LOWER THIRD OF FEMUR.

Curves of the femur are very frequently found in cases of knock-knee. They may be in various directions, but by far the most common are the anterior and internal. The former involves the middle and lower thirds; the latter is generally confined to the lower third. Though the anterior curves often complicate the case, they cannot be said to have any share in the formation of knock-knee. It is quite otherwise with the internal curve. Out of 166 limbs belonging to 100 knock-kneed patients, 120 were found to have abnormal internal curves in the lower thirds of the femora. In 12 of these there was an anterior curve in the middle third and partly in the lower, combined with the internal curve. The exact degree of curvature in each case was not indicated further than by the expression slight and marked. In this way 48 were estimated as slight, and 72 as marked.

In many instances where the limbs are thin, the contour of the lower femoral third may be easily discerned, without the aid of touch, as the patient lies in bed. In others, however, the soft parts are more abundant, and somewhat obscure the aspect of the bone. In such cases the femoral contour may be made out by pressing the tissues aside, moulding a leaden rod to the shape of the bone, and taking a tracing of this on paper. In this way the femur will be seen to have a more or less pronounced curve, the convexity facing inwards, while the condyles are thrown with their articular surfaces facing outwards. The extent to which the femur is involved in this curve is very variable; sometimes a little over the lower third, at times the lower fourth or fifth, is alone implicated; but speaking generally, the lower third is the part affected. In some instances, so marked is the twist, one could imagine that it could be produced by placing one hand on the thigh, the other on the condyles, then using the operator's knee, placed on the outside of the patient's femur, as a fulcrum, and so bending the bone. There are other cases where the femur is straight, but the inner side toward the lower third is longer than the outer, and consequently the position of the condyles is relatively altered, the inner being depressed, while the outer remains as before.

Fig. 5 is a section of a normal femur, showing the epiphysary line and the relation of the epiphysis to the diaphysis. Fig. 6 is a section of a femur affected with genu valgum, showing the increase of osseous matter on the inner side of the diaphysis, thereby placing the internal condyle on a lower level than the external. While this is so, the relative sizes of the condyles remain the same. This drawing is taken from a specimen figured by Mikuliez. The appearance presented is much as if a wedge of new bone were inserted in the lower third of the femur, above the epiphysis, the base of the wedge being on the inside of the diaphysis, the apex terminating at the outer third of the shaft.

It is possible that even here there may have been originally a little twisting, but that secondary formations have so far obliterated the primary appearance. This is supported by the fact that, in many such cases, there is found on the inner side of the diaphysis end an inward prolongation of the bone which affects the upper part of the condyle.

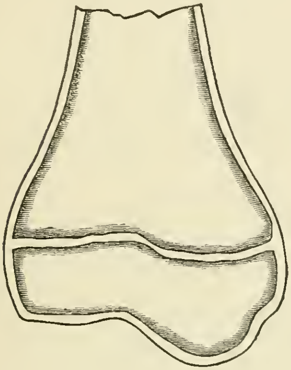

Fig. 5.—Longitudinal Section of Distal Extremity of Normal Femur.

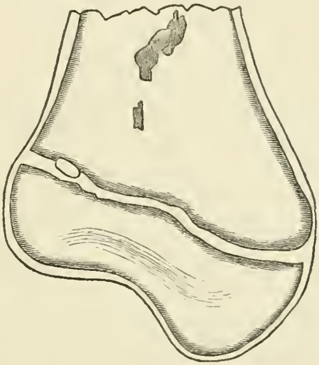

Fig. 6.—Longitudinal Section of Distal Extremity of Femur affected with Genu Valgum.

Regarding the curve to the inner side, in the lower third of the femur, there can be no dubiety about its primary origin, as it is often met with as one of the earliest indications of knock-knee, and goes on increasing as the deformity advances. This curve also forms one of the most important factors in the formation of knock-knee; often it is the sole factor, but commonly it is combined with the increase in length of the internal condyle, especially as age advances.

ELONGATION OF INTERNAL CONDYLE.

The fact that the internal condyle is generally found at a lower level than the external led many to the belief that knock-knee was the result of the abnormal elongation of this part, and that the internal condyle was the sole factor in the formation of knock-knee. From this extreme view some have recently passed to another extreme, and deny the existence of abnormal elongation of the internal condyle in knock-knee, stating that though this condyle presents the appearance of elongation to the casual observer, it is only because the epiphysis is placed askew on the diaphysis, so that the internal condyle sits on a lower level than the external, yet, intrinsically, it is not elongated.

In order to ascertain what the normal average relative difference between the condyles is, Dr. Clark, Lecturer on Anatomy to the Royal Infirmary, examined 100 adult femora, and he found that the internal condyle averaged about a quarter of an inch over the external condyle. Then 166 limbs (belonging to 100 patients) affected with knock-knee, who were admitted to my wards, had their condyles measured from the same fixed points as were taken by Dr. Clark in his normal measurements, when it was found that 117 instances, or 70 per cent., had an abnormal increase in the length of the internal over the external condyle. But a quarter of an inch of difference was considered by Dr. Clark to be a fair average for the adult limb, and if inquiry be made into the ages of the 43 cases in which "normal" is marked, on account of there being only a quarter of an inch of increase of the internal over the external condyle, it will be found that 23 limbs belonged to persons below ten years of age, who normally would have a less difference than a quarter of an inch between the length of the internal and the external condyles, and therefore these 23 limbs had internal condyles which were abnormally elongated, giving a percentage over all of 84, in which the internal condyle was abnormally elongated. This leaves 24 cases out of 166 in which no elongation of the condyles was found. In 2 instances there was an abnormal shortening of the internal condyle, as compared with the external. Of the 117 instances in which the internal condyle was over the normal length, the extent of the abnormality in 14 cases was under a quarter of an inch; in 54 instances it was a quarter of an inch; in 35 it was over a quarter and not more than half an inch; in 9 it was between a half and under one inch; in 4 it measured an inch; and in 1 it was an inch and a quarter.

So it is clearly established that, in the majority of instances, there is an abnormal elongation of the internal condyle in genu valgum.

INWARD INCREASE OF THE INTERNAL CONDYLE.

Besides the elongation, there is, in many cases, an increase of the internal condyle, in an inward direction, accompanied at times by an antero-posterior flattening, ending in a sharp ridge; in others, confined to the condyle, ending abruptly at the spine for the insertion of the adductor magnus tendon; in some it is more or less continuous with the diaphysis, gradually tapering off as it proceeds up the shaft. Sometimes the formation of the bones is such, that a perpendicular line is formed, running from the spine for the attachment of the adductor magnus tendon, to the spine, or spines, on the tibia. At times the patella is thrown so far to the outside in genu valgum that it rests on the outer condyle, even in extension, and then the inner condyle appears increased inwards when in reality it may not be so; this, however, can be easily distinguished from the true inward lengthening by measurement of the condyle. This increase of the condyle in an inward direction, though contributing nothing to the tibial displacement, shows that the internal condyle is actually affected pathologically and increased in bulk, or at least its growth is changed in direction in genu valgum. This fact gives support to the actual perpendicular lengthening of the condyle, as it shows that there are forces at work in the internal condyle which at least alter its shape. The actual measurements show that there is a perpendicular elongation. The flattening of the internal condyle and its inward increase may be regarded as a secondary formation, and in this way may be placed on the same footing as the tibial spines. Data are wanting to enable an opinion to be formed as to whether the perpendicular lengthening of the internal condyle is primary or secondary: but from the fact that in some few cases it is the only factor occasioning knock-knee, it must be presumed that in such cases, at least, the perpendicular lengthening has a primary origin.

This elongation of the internal condyle is not, however, in itself sufficient to account for the whole deformity in the majority of cases. This may be seen in two ways: first, because in most cases the amount of the perpendicular elongation does not account for the whole of the angle; and secondly, because there are other factors present which contribute their quota to the deformity. By far the most important of these is the internal curve of the lower third of the femur, with its consequent twisting outwards of the condyles.

THE PART PLAYED BY THE TIBIA IN THE FORMATION OF KNOCK-KNEE.

The relative normal length of the inner as compared with the outer side of the tibial head, has not been ascertained in a satisfactory manner, and therefore the measurements in the knock-kneed can scarcely be well weighed. Again, it is somewhat difficult to get precise information of the relative sizes of the tibial head from want of fixed points to measure from. With the means at disposal, however, the data afforded show that in about two-thirds of the cases of knock-knee, the tibiæ are not affected to an appreciable extent, the remainder having the tibiæ affected in various ways and to various degrees. There is a tibial affection which occurs in about 10 per cent. of the cases of genu valgum. It consists in the tibial shaft being placed at an angle to the head of the bone, the lower part of the limb running outwards. In two instances a somewhat similar deformity, but commencing toward the lower portion of the upper third, was met with, in which there was no part of the femur involved; and therefore they, though simulating knock-knee, were not really cases of that kind, and were consequently placed under the heading of tibial curves. Besides this angular union of the shaft to the head, there is combined with it an amount of anterior curvature in the middle and lower thirds. In such cases the tibia, which is broad and flattened antero-posteriorly above, becomes, as it descends, flattened laterally, forming a veritable twist in the bone, which presents a formidable deformity for treatment. These tibial deformities mostly arise during early years, and in the knock-knee of adolescence, there is almost entire immunity from

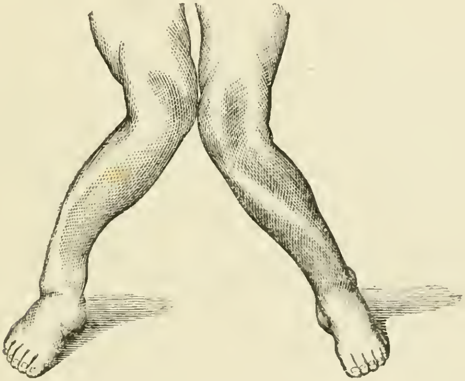

FIG. 7.—CASE OF GENU VALGUM COMPLICATED WITH TIBIAL CURVES.

them. Fig. 7 shows a case of knock-knee complicated with anterior tibial curves and twisted tibiæ, taken from a cast of a patient previous to operation. The genu valgum is here made secondary to the form of the tibiæ, consequently the knock-knee is not brought out as in the normal limb.

TIBIAL SPINES.

Spines situated at the inner border of the upper third of the tibia are a prominent feature in many cases of knock-knee. They are most apt to arise the earlier the knock-knee is produced, and in the majority of cases of genu valgum adolescentium they do not form. Out of 100 limbs affected with knock-knee, 69 per cent. had spines on the inner side of the upper third of the tibia. In 54 of these one spine was present; in 15 double spines were found, leaving 31 in which there were no spines.

These spines are secondary formations, always coming on after the knock-knee has been formed, and only arising when the patient walks. In several instances, when the patient had knock-knee at an early period of life, and through weakness was compelled to desist from walking during some years, the spine only began to form after the patient was so far recovered as to be able to resume walking. These spines are often associated with a flattening and an inward prolongation of the tibial head.

The position of these spines is the inner side of the tibia, sometimes lower, at others higher, than the foot of the anterior tuberosity. In one instance, they were as far as three inches from the articulating surface of the tibia. They form a distinct prominence on the inner side of the tibia, at times having their edges rounded, at others being sharp and pointed, so much so that firm pressure with a bandage would cause them to penetrate the skin. In some well-marked cases of knock-knee, the femoral internal condyle and the tibial spine were on a perpendicular level internally, while the femur and tibia receded in an outward direction from them. When one spine is present in the adolescent, it is generally well marked, and visible to the naked eye. Some single spines have a notch at their apex. Some double spines are situated on a common ridge uniting their base; others are independent of one another, being occasionally situated some inches apart, and projecting beyond the normal outline of the bone.

As these spines are situated near the insertion of the internal lateral ligament, it was at first supposed that the strain put on this ligament by the position of the joint in knock-knee, was the cause of their formation. One such spine could be accounted for in this way, but it is difficult to see how this could produce several, situated one lower down the limb than the other. Besides, some of these spines are situated at a lower level than the attachment of the ligament. Again, spines of a similar kind are found, though not to such a marked extent, at the points of greatest convexity of other deformed bones, and these are often in no way associated with the origins or attachments of tendons or muscles.

In genu valgum arising during adolescence, tibial complications are very rare.

As a consequence of the osseous malformation the muscles and their tendons become relatively affected. The malposition of the patella and its ligament has already been noted. The biceps flexor cruris, in marked cases of genu valgum, is shortened, and its tendon stands out, as a tense band, on the outer side of the knee.

Résumé.—Genu valgum is an osseous deformity of the lower extremity, consisting, as a rule, of more than one element. The most constant factor is an inward curve of the lower third of the femur, which lowers the level of the internal and raises that of the external condyle. The second factor is an abnormal elongation of the internal condyle, which is frequently found and generally associated with the inward curve of the lower third of the femur. These, separately or combined, form the chief pathological anatomical features in knock-knee. There is another element found in about one-third of the whole number of cases, consisting of an increase of osseous matter on the inner side of the tibial diaphysis at its proximal extremity, which causes the head to sit askew on the shaft. This tibial deformity, when present, is so to a small extent, though in a few it forms a prominent feature. In some cases a somewhat similar osseous increase is found on the inner side of the epiphyseal junction.

CHAPTER VI.

GENU VARUM AND TIBIAL CURVES.

GENU VARUM: SYNONYMS—DESCRIPTION OF GENU VARUM—PATHOLOGICAL ANATOMY—GENU VARUM ET VALGUM IN THE SAME PERSON—TIBIAL CURVES.

Genu Varum, Genu Extrorsum, Exogonyancon—Bow-legs — Sabelbein, Sichelbein, O-Bein — Genou en dehors.

DESCRIPTION OF GENU VARUM.

In discussing the ætiology of deformities generally, it was seen that rickets was traced to be the predisposing cause of genu varum, and that the weight of the body was the factor producing the curve. It was further seen that rickets, while being a constitutional affection, did not always attack all parts of the body with equal force, neither did it always attack individual bones with equal intensity in all parts; that at times it showed itself most particularly in the shaft of the long bones, at others, it was confined chiefly to their extremities. In this election of site which attended rickets was found a probable determining point between genu valgum and varum, as the latter would be associated with those cases where the shafts of the long bones were softened. This probability, from an histological point of view, is greatly strengthened by the pathological anatomy of genu varum.

PATHOLOGICAL ANATOMY.

Genu varum is an affection of the shafts of the femur or tibia, but most often of both. These parts are curved, the convexity being outwards, imparting to the limbs more or less of a bowed form. A perpendicular line from the head of the femur to the middle of the ankle-joint, would have the middle of the knee to the outside of it (see Fig. 8). The amount of deformity is very variable, from a slight bend to that of almost a complete circle. The foot is sometimes flattened in bow-leg.

The femur is often bent outwards in the middle and lower thirds, but in aggravated cases the whole femoral shaft is curved. At times the curve in the femur is scarcely noticed, and there are not a few cases where the femur is straight, the whole deformity lying in the tibia and the laxity of the knee-joint. Consequent on the femoral bending there is often an abnormal lowering of the external condyle, but in many cases this does not obtain, the condyles retaining their normal relations.

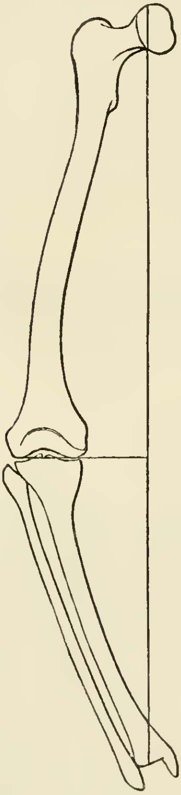
Fig. 8.—Schematized Drawing of Genu Varum.

The bending of the tibial shaft is even more frequent than the femoral deviation. Often the entire shaft is curved outwards, but it is most marked at the lower and upper thirds, the former being the most constant, though the least important, factor in genu varum. The bend in the upper tibial third is variable in position, most often commencing immediately below the anterior tuberosity; at others, lower down, and this part is more constantly involved than the femur. Besides the outward curve there is very often a lateral or oblique flattening of the tibia. The fibulæ, though of much less importance, participate in the tibial deformities. So that genu varum is very variable, it is an outward curving of the shafts of the femur or tibia, or both; the particular locus must be found in each individual.

Fig. 9 is a woodcut taken from a photograph of a patient sixteen years of age, who was affected with bow-leg. The femora are slightly implicated, the tibiæ markedly so. Fig. 10 is a woodcut from a photograph of a patient eighteen years of age, affected with marked bow-leg, the three bones being involved to a marked extent.

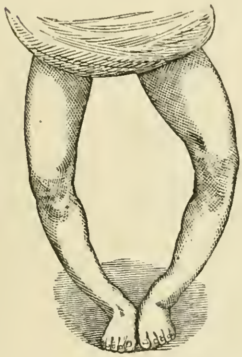

FIG. 9.—MODERATE DEGREE OF GENU VARUM.

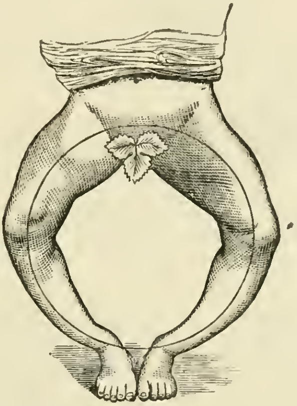

FIG. 10.—MARKED CASE OF GENU VARUM.

GENU VARUM ET VALGUM IN THE SAME PERSON.

When there is genu valgum in one limb, and varum in the other, some might assume that rickets being a constitutional affection, it would necessarily involve both limbs alike. That it does so as a rule is clear ; but in the comparatively small number of cases in which bow-leg is present in one limb, and knock-knee in the other, the exceptions to the rule in which the shaft of one femur is softer than its fellow, and more easily bent, ought to be taken into account. While operating first on one limb then on the other at the same sitting, one femur has sometimes been found harder than its neighbour; this fact would tend to support the idea that there may be differences in the bones of either side of the same individual, as may be further demonstrated by the fact that one leg is sometimes affected with knock-knee, the other remaining straight. But besides this, spinal and pelvic malformations, the peculiarities of form in the femoral neck, may assist in producing this combined deformity. Fig. 11 represents a slight degree of bow-leg along with knock-knee in the neighbouring limb.

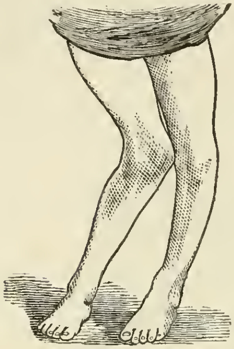

Fig. 11.—Genu Valgum and Varum in Same Person.

TIBIAL CURVES.

Tibial curves are chiefly incidental to those who are affected with rickets during their earlier years, few commencing after five years of age, and the majority being formed during the second and third years. Once formed, they may go on increasing till the period of eburnation sets in; or they may be arrested and afterwards increase, if the bones from some cause are again softened. The tibia may be curved in a great variety of ways. Besides those mentioned under genu valgum and varum, there is the anterior curve, which may affect the entire shaft, or be confined to one part—often the lower third. In such cases there is almost always a lateral flattening of the tibia. There are often combinations of the anterior with an external, or more frequently with an internal curve. In some cases the lower part of the tibia comes in contact with the ground, at the same time as the inner border of the foot, the sole not touching the floor. The fibula generally follows the same curve, but not always, as, in two instances, cases of very aggravated tibial distortions were accompanied by straight fibulæ, resembling one figured in Paget's "Pathology." *

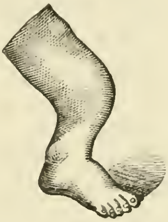

FIG. 12.—TIBIAL CURVE, INVOLVING WHOLE SHAFT.

Fig. 12 is a woodcut taken from a cast representing the limb of a patient, seven years of age, affected with marked anterior tibial curvature, involving the whole shaft. The neighbouring limb was likewise affected, but not quite to the same extent.

Fig. 13 is taken from a cast of the limbs of a patient affected with anterior and inner curves of the tibia. The right limb at its lower third, and the left somewhat higher up the tibial shaft, are so much bent, that they come in contact with the floor on the patient attempting to stand, while the feet are everted, the soles only coming in contact with the ground on their inner side. The patient, who was nine years of age, in this case could not walk unsupported, generally walking with crutches, or creeping.

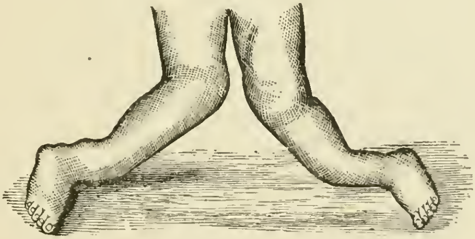

FIG. 13.—CURVES AT LOWER THIRD OF TIBIÆ, TIBIÆ RESTING ON FLOOR.

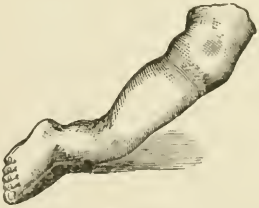

FIG. 14.—ANTERO-LATERAL TIBIAL CURVE, TIBIA RESTING ON FLOOR.

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* See Paget's Case, "Pathology," vol. i.

Fig. 14 represents the right limb of a patient, seven years of age, who was affected with a somewhat similar deformity, the lower third of the tibia at its inner aspect resting on the floor. The limb having been used much by the patient, a bursa was found over this prominence. The sole did not touch the floor, the weight being thrown on the tibia and inner side of foot.

CHAPTER VII.

HISTORY OF OSTEOTOMY.

DEFINITION—OSTEOTOMY BY OPEN WOUND—SUBCUTANEOUS OSTEOTOMY—ANTISEPTIC OSTEOTOMY.

DEFINITION.

Osteotomy, in its broadest acceptation, may be defined as a section of bone. It has, however, been regarded in a much more restricted sense, the term being applied to such divisions of bone as have been proposed and undertaken for the relief of deformity, for the rectification of badly united fractures, and for the straightening of limbs affected with osseous anchylosis, and which were fixed in bad positions.

HISTORY: OSTEOTOMY BY OPEN WOUND.

Osteotomy for the correction of badly united fractures and the rectification of so-called vicious callus, was performed in 1815 by various surgeons, Key and Lemercier being among the number. The earliest osteotomy for the rectification of anchylosis seems to have been performed by Dr. John Rhea Barton, in 1826, and Dr. Gross gives the following description of it*:—"A crucial incision was carried through the integuments over the most prominent part of the great trochanter; when raising the flaps thus defined the muscles connected with this portion of the bone were detached, a passage being thus made both in front and behind the femur for the easy introduction of the finger. With a saw, constructed for the purpose, the bone was divided through the great trochanter, and a part of its neck in a transverse direction." This case was successful. Dr. Barton, in 1835, performed osteotomy for anchylosis of the knee, removing a wedge of bone through a wound in the shape of "a triangular flap formed of the soft parts in front of the limb, consisting of the integuments and extensor muscles," which were directed up and held out of the way. "Of 14 cases of this operation, of which the results have transpired, 12 recovered and 2 perished respectively of hectic irritation and exhaustion. The success would thus seem to be eminently flattering."

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* "A System of Surgery," by Samuel D. Gross, 5th ed. vol. i. pp. 1092 and 1093. London: Smith, Elder, & Co. 1872.

SUBCUTANEOUS OSTEOTOMY.

From those operations by open wound, performed by an American surgeon, chronological history leads us to Germany, and to a new principle under which osteotomy was performed. During the Schleswig-Holstein war, Langenbeck used a small, straight-pointed saw, which he introduced through bullet wounds for the purpose of removing portions of splintered bones. The idea of performing subcutaneous section of bones then occurred to him, and in 1852 he performed subcutaneous osteotomy for anchylosis of the hip-joint, and in a second case for anchylosis of the knee. Between this date and 1854 he had operated in a similar way on some cases of rachitic deformity of the leg. His method of operating consisted in perforating the bone with a drill, a quarter of an inch in diameter. Into the aperture so made he inserted a saw, having a narrow sharp point, an eighth of an inch in width and four inches long, with which he divided the bone almost completely, the remaining portion being broken and the limb straightened. Suppuration ensued in most of these cases. After Langenbeck other

German surgeons adopted the idea, but modified the procedure and apparatus, chain saws, trephines, and, lastly, the chisel (first used by Billroth) being substituted for Langenbeck's original instruments. Another method was introduced and practised by Professor Pancost, of Jefferson's Medical College. In the winter of 1859 he perforated the femur at half a dozen points with a stout gimlet, through a single subcutaneous opening. This was done just above the knee, in a case of anchylosis of the knee-joint. A large abscess formed at the seat of fracture, but with this exception the case progressed favourably, and the boy made a good recovery. The femur has also been operated on in a somewhat similar manner by Professor Brainard in 1860, who used a perforator instead of a gimlet.

The operation of Mr. Stromeyer Little* in 1868 for bony anchylosis of the knee may be described as the first subcutaneous osteotomy in England. A strong carpenter's chisel, rather more than a quarter of an inch wide, was taken, "and driven with a mallet through the united bones in several directions." Mr. Little, though performing an undoubted osteotomy, seemed to aim at separating the tibia from the femur, as may be gathered from the description—"The careful separation with a small chisel and a mallet of the firmly united femur and tibia. . . ." The patient, a girl, fourteen years of age, recovered perfectly, with a limb which was much straighter, though the deformity was not entirely removed. In December, 1869, Mr. William Adams divided with a saw the neck of the femur subcutaneously, in a case of bony anchylosis of rheumatic origin, and has since several times repeated the operation. Mr. Gant has likewise divided the femur subcutaneously, performing his operations through the shaft in cases where the neck of the femur had been obliterated.

Up to this period there have been two principles under which osteotomies have been conducted—by open wound and subcutaneously. Although some of the earlier osteotomies were from their very nature conducted with open wounds, the majority of the more recent were attempted to be made subcutaneously. The important difference between injuries connected with open wounds and those which were subcutaneous was recognized by Hunter. Though Hunter was so well aware of this fact, he never practised subcutaneous surgery with the exception of having divided some tendons subcutaneously in animals. Delpech was the first to perform a subcutaneous tenotomy, which he did in 1816, which, however, was not very successful, and he did not repeat it. It was not till 1831 that the principle was revived and the method of operation improved and practised by Stromeyer. There can be no doubt that the extension of the subcutaneous method and its more general adoption is due to the work of Jules Guérin, who collected many facts bearing on subcutaneous operations and injuries, and showed the great immunity from inflammation which they enjoyed when contrasted with those having open wounds. No one doubts the immense advantage accruing from subcutaneous principles. Its introduction must be regarded as a great step in surgery, and as applied to the division of tendons, where the exclusion of air and its contents can be completely insured, its results leave little to be desired. When the principle is attempted to be applied to the division of bones, it is not so fortunate, as it has decided practical difficulties. In the first place, the wound necessary for the introduction of the saw or chisel is larger than that required for the insertion of a tenotome. Secondly, the division of the bone occupies a longer time and involves greater manipulation than that of a tendon, and during the time the instrument is *in situ*, a direct communication between the bone and the external atmosphere is in many instances established. In the case of the saw the to-and-fro movement necessary for its application is apt to pump air into the tissues. For these reasons it is scarcely possible to carry out an extended series of osteotomies in a thorough, subcutaneous manner.

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* "Medico-Chirurgical Transactions," vol. liv. p. 247.

Deep-seated suppuration is confessed by many advocates of subcutaneous osteotomy to be not uncommon, though they express their belief that when it does occur, it is probably due to injury of deeply seated structures. While admitting that such injury to deeply seated structures, especially the soft parts, is a fruitful source of pus, it is scarcely likely that such injury would often result in the hands of surgeons of European reputation, while the alternative of the temporary exposure of the tissues to the unguarded atmosphere is sufficient in itself to produce the evil.

Even granting the possibility of many osteotomies being conducted subcutaneously, when the instruments are in dextrous hands, still there is always the element of uncertainty and the risk of failure, in consequence of the admission of contaminated air.

Whatever may be the difference of opinion on this point, there can be no doubt about the fact that osteotomy by open wounds gave results which caused it to be seldom performed, and was regarded by the bulk of the profession as foolhardy, and never gained ground among them.

Subcutaneous osteotomy had certainly better results, but though adopted by a number of surgeons, and that with considerable success, it yet did not meet with general favour; its progress was slow, many regarding it as too dangerous, and eschewing it altogether. It is questionable whether osteotomy would not have remained an operation confined to the few, or whether it would not even have made a retrogression, had it not been for the introduction of another principle which rendered the operation safe and certain.

ANTISEPTIC OSTEOTOMY.

Great as were the advantages of the subcutaneous principle in surgery, they waned on the advent of antiseptics.

The principles of antiseptic surgery, as propounded by Lister, are too well known to require description. It is interesting to note, however, as a phase in the history of surgery, how, in the wards of the Glasgow Royal Infirmary, Mr. Lister, from 1867, patiently laboured to render his antiseptic principle practical, performing experiment after experiment, from carbolized bullock's blood, putty, lac plaster, oily, watery, and other solutions, up to gauze, jaconet, protective-plaster, and spray; and all this despite the scoff and ridicule with which it was at first received, and the subsequent apathy of English surgeons. It was not, indeed, until the principle, having passed unheeded over the land of Pasteur, was discussed, adopted, and practised in Germany, that it began to be fully recognized and appreciated in this country. The extent to which the antiseptic principle has since been adopted may be gathered by the ovation accorded to its promulgator by the International Medical Congress held in Amsterdam in September, 1879.

By a strict observance of antiseptic principles, osteotomy may be performed with perfect immunity from inflammatory products, and a compound incision or fracture of bone may be regarded as a simple one. What the subcutaneous principle did for tenotomy, antiseptics has done for osteotomy.

The honour of introducing antiseptics into osteotomy is due to that celebrated German surgeon Volkmann, of Hallé. In the "Edinburgh Medical Journal" for March, 1875, Volkmann publishes two cases, in which he performed antiseptic osteotomy for anchylosis of the knee-joint. These were performed on girls, thirteen years of age, who had been the subjects of white swelling in the knee, afterwards becoming contracted and anchylosed at a right angle. The limbs were straightened, and the operations were entirely successful.

On April 11th, 1875, I performed antiseptic osteotomy on a girl, six years of age, who had osseous anchylosis of the right knee, following suppuration of the joint, rising as a sequela of scarlet fever. The limb was straightened, and the wound healed as a typically antiseptic wound does. This was the first case of antiseptic osteotomy performed in Britain. The second was performed by Lister during the winter session 1875-76. Ogsten, of Aberdeen,* performed, on May 17th, 1876, his operation for genu valgum, as a subcutaneous antiseptic operation. Antiseptic osteotomy was performed for the first time in London by Mr. Barwell,† on December 2nd, 1876. During the last few years antiseptic osteotomy has been greatly extended, and it has met with such success as to ensure it a permanent place as a safe, certain, and most successful procedure.

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* "Edinburgh Medical Journal," March, 1877, p. 782.

† "British Medical Journal," April 28, 1877, p. 506; also see foot-note to letter on "Osteotomy," in same journal, May 5, 1877.

CHAPTER VIII.

THE INSTRUMENTS REQUIRED FOR OSTEOTOMY.

INSTRUMENTS THAT HAVE BEEN USED—SAW AND CHISEL COMPARED—CAUTION IN SELECTING INSTRUMENTS—THE CHISEL—THE OSTEOTOME—MALLET AND OTHER INSTRUMENTS.

INSTRUMENTS THAT HAVE BEEN USED.

When the surgeon is about to perform an osteotomy, his attention is naturally directed towards the kind of instrument required, and as the success of the operation depends in a great measure on their proper selection, some remarks on this subject will not be out of place.

A variety of instruments have been employed for the performance of osteotomy, including trephines, bone perforators, gimlets, chain saws, round saws, ordinary saws, some suitable for open, and others for subcutaneous section; and, last of all, chisels.

SAW AND CHISEL COMPARED.

Langenbeck's saw for subcutaneous osteotomy has been much used on the Continent, while in this country Adams's saw is the one in general use. The latter is a small saw, "rather more than a quarter of an inch in width, with a cutting edge an inch and a half in length, at the end of a blunt shank three inches in length." This is the description of the one used by Adams for subcutaneous division of the neck of the femur, but various sizes may be obtained to suit the case. Adams's saws have been used for division of the internal condyle of the femur, and Mr. Adams has divided the tibia subcutaneously with one of these instruments. A considerable number of surgeons prefer the saw to the chisel, as they believe it to be much more easily used, and they state that it is equally efficient. One of the conclusions which Langenbeck came to regarding subcutaneous section of bone was—"Healing of subcutaneous section of bone will not take place as in a simple fracture, for the reason that the drill and saw produce some powder, which acts like a foreign body, and therefore some suppuration will take place." Though this conclusion is not borne out in a large proportion of cases in which the saw has been used, the particles of bone being absorbed, still, there can be no doubt that in some instances the bone dust does act as a disturbing element, and when it can be avoided by the use of another instrument a point is gained. In the selection of an instrument for the performance of osteotomy the desideratum is to secure one which will effect the osseous divisions with the least disturbance of the soft parts. When the saw is introduced into a subcutaneous wound so as to come into contact with the bone, there is still the danger of laceration of the soft parts on either side of the bone while the saw is in action—besides the likelihood of air being pumped into the tissues by the to-and-fro movement. The chisel is not liable to these objections. Once the sharp edge is passed through the soft tissues to the bone, there is nothing further to fear; it in no way lacerates the soft parts, and it makes a fine clean osseous incision without leaving *débris*. It is beautifully adapted for this purpose, and I quite agree with Billroth in regarding it as the true "*bistouri des os*." It is, however, a most powerful instrument, and its proper selection and method of use are highly important to the successful issue of the case.

CAUTION IN SELECTING INSTRUMENTS.

The statement made by some surgeons that it is a matter of little moment what kind of chisel is used, that an ordinary carpenter's chisel is quite as suitable as any other, is misleading. Acting on this advice, a surgeon procured a pair of chisels at a carpenter's shop, with which he performed a non-antiseptic osteotomy. The patient died in twelve hours from hæmorrhage and shock; a surgeon present at the operation informing me that the operator had great difficulty in performing the osteotomy, owing to the fact that the chisels would not take the desired direction, and the fatal issue was ascribed by those present, mainly to the unsuitableness of the instruments. A case came under my own observation, where a surgeon, wanting to make a straight incision, used a thick chisel in form like a carpenter's, which first made an oblique incision downwards, and on withdrawal and re-insertion with the sides of the chisel reversed, ended in the production of a zig-zag osteotomy, accompanied by considerable comminution. The effect was disastrous, the patient dying in a few days. On the other hand, chisels have been used which were unsuitable in temper, and various surgeons have left pieces of their chisels in the bone.* A celebrated London surgeon informed me that he had used a chisel which snapped while in the bone, and half an inch of the extremity was left in the patient's limb. Though no bad effects followed up to the time of the communication of this fact, he naturally preferred that such an accident should not happen again. In some of these cases the form of the instrument, in others the temper of the steel, was at fault. These are sufficient to show that the form of the instrument, its temper and quality, are of considerable importance.

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* De Santé ("Revue Critique"—"Archives Générales de Médecine," vol. i. 1879) states that Billroth and Boeckel have broken the points of their chisels, which remained fixed in the bone, and produced serious effects.

THE CHISEL.

The instruments used by me are of two distinct kinds, the chisel and the osteotome, the former being of the same form as the carpenter's though different in temper; the latter being shaped like an attenuated double inclined plane. The chisel is used for paring, shaving, and cutting wedges of bone out, such as removing a cuniform portion from the tibia in anterior curvature. The osteotome is used only for making simple incisions, or wedge-shaped openings *without* removal of bone.

The blade of the chisel has two parallel sides extending as far as the cutting edge. The cutting surface has one side straight, the other bevelled. It ought not to be too thick, otherwise the bone will splinter. For most purposes an eighth of an inch at the base of the bevel is suitable. The breadth of the instrument varies according to the size of the bone. Half an inch broad is found very suitable in the majority of cases; but for narrow fibulæ, a quarter of an inch is better. The breadth ought always to be less than that of the bone to be divided, otherwise the soft tissues on either side would be apt to be cut. Though the form of the instrument is similar to many employed by the carpenter, yet the temper and quality are quite different. A chisel tempered so as to cut wood, such as a carpenter's, would not be suitable for cutting bone. On the other hand, the instruments employed by the iron dresser would be equally faulty in thickness and temper. The bone would be apt to turn the edge of the former, while the latter would be apt to splinter the bone. The nearest approach to the requisite temper will be found in the tools of the hard wood or ivory turner; but it is best to get the chisel tempered to suit bone, and its quality may be easily tested on the thigh-bone of an ox. The quality of the steel used, and the exact temper, are the same as are required for the osteotome. The edge of the chisel ought to be kept very keen, so as to catch the bone when brought in contact with it, and to take away fine shavings when required. The osseous surface left by a sharp chisel ought to be quite smooth.

This instrument is used for the purpose of cutting a wedge and removing it out of the bone. If one attempted to perform a simple osteotomy with the chisel, more especially if the bone were thick, he would find that the chisel would go to the one side the further he drove it in, notwithstanding his efforts to maintain it in a straight line. No carpenter or joiner would employ a chisel for the purpose of cutting straight through a piece of wood several inches thick, knowing that if this were attempted an oblique incision would be made instead of a straight one. For the purpose of making a simple osteotomy, or in order to have a wedge-shaped opening in the bone, without removal of any osseous substance, an osteotome is employed. An osteotome, on the other hand, is not the best instrument for the removal of a wedge.

THE OSTEOTOME.

The osteotome is an instrument of the chisel order, bevelled on both sides, so as to resemble a very slender wedge. The handle and the blade form one piece. The handle is octagonal, which is preferable to the oval or cylindrical, as it affords a better grip, and enables the operator to readily detect any deviation which the instrument might assume while in the wound. The top of the instrument is furnished with a round projecting head, against which the thumb of the operator rests as he steadies the instrument; it also serves as a support whereby the osteotome may be gently levered out of the section. One of the borders of the blade is marked with half inches, the figures being extremely delicate. The thickness of the bone can be ascertained in many cases, and thus the distance to be penetrated can be predetermined. The figures on the border of the instrument indicate the depth to which it has penetrated, and thus they serve as a guide. It is finely polished or burnished, not for appearance, but because the finer the surface the less opportunity will organic matter have of becoming adherent and of afterwards decomposing. It has sharp cutting edges which grip the bone when they are pressed in contact with it. The sharpness may be tested by seeing whether they will pare easily the finger-nail. This attenuated double inclined plane has its apex at the cutting edge, and its base where the blade joins the handle. This instrument ought to be made to suit the material upon which it is to act, not only in respect to its form but also as to its temper and the "stuff" of which it is made. It ought to be made of very fine steel, tempered so as to prevent brittleness or too great softness. If it is brittle it may snap and leave a portion of metal in the tissues; if too soft it will turn and curl up at the edge. Of the two evils, the latter is the least. Mr. Macdonald put himself to some trouble to carry out my instructions concerning the manufacture of these instruments, and also in determining the exact temper necessary. As the latter is a matter of considerable importance, the particulars arrived at may be mentioned in a couple of sentences. They were made from Stubbs' finest five-eighths steel, forged at a low heat; tempered by raising the instrument to a cherry-red heat, dipping it into oil, and then plunging it into water until cold: next polished, and about an inch of the chisel, measuring from its cutting-edge, having its temper drawn back by raising it to a copper-yellow colour with purple spots (probably a temperature of 520° Fahr.), so that only a small portion of the blade embracing its cutting-edge is raised to a great degree of hardness; the remainder of the blade is comparatively soft, so as to avoid the possibility of snapping. Though this particular is applicable to all the osteotomes, it is especially so to the most slender of them, especially when used where the bone is thick and the instrument has to be deeply inserted. A good material for testing the edge of the instrument is the thick part of the "hough" bone of an ox. If one finds that the instrument will neither turn nor chip in penetrating such a bone, it may be concluded that it is well suited for cutting any human bone.

Such instruments pass easily into the bone and maintain the direction given to them by the hand, having no tendency to glide to one side or the other. They are easily withdrawn, and are not so apt to become fixed as a chisel with a shoulder, such as a carpenter's. If the bone be large and very dense, several osteotomes ought to be used. The first, being the thickest, performs the first third, or half, of the intended incision; the second, of medium thickness, is introduced into the groove made by the first, and comes into play directly on the deeper layers of bone. A third, still finer, may be used if necessary. On the other hand, in the adolescent the bone may be found sufficiently yielding to permit the osteotomy to be completed by a single instrument, the aperture assuming the shape of the osteotome, cuniform, with the base toward the part where the incision commenced. Though one instrument may be sufficient, still, for delicacy of touch, the finer instrument being used after the thicker, it is not pressed on laterally as it is in the wide groove previously made by its thicker fellow, and only comes into contact with the parts at its apex.

Although there is nothing new in the principles on which this instrument is formed, yet its exact counterpart cannot be found out of surgery, and though clearly of the chisel order, it has sufficient individuality to enable it to take a distinctive name, which at the same time distinguishes it from the chisel, which is also used in certain kinds of osteotomies. As the blade in shape resembles somewhat a transverse section of the blade of a pocket-knife, and as it cuts much in the same way, it might be described as a knife for cutting bone, or, to employ a single word which would at once distinguish it from the ordinary chisel, and at the same time be more euphemistic to a patient's ear, it has been termed an osteotome.*

The set of instruments are made as nearly of the same weight as possible, so that the hand, accustomed to the sensations communicated through one of these instruments, may not be thrown out of its reckoning by having a heavier or a lighter instrument turn by turn. Even the chisel is made of the same weight for similar reasons. It is also of some moment to use the same mallet, as the impelling force may then be nicely balanced. Being all in one highly polished or burnished piece, with few or no crevices in which foreign matter may lodge and decompose, these instruments are easily cleansed, and the surgeon ought *himself* to see that they are clean, as scrupulous cleanliness is a very important element of success. If they are not clean before being used, they will probably clean themselves in the wound, leaving in the soft parts, or on the osseous tissue, the foreign substance, and so probably inoculate the tissues with decomposing matter.

These osteotomes have been used by me in a great variety of cases, having performed hundreds of osteotomies with them, many of the bones being hard and brittle, others soft and easily cut, and they have answered admirably. The first set have been, and are still, in constant use, and they are in no way impaired, the largest having on two occasions been rubbed on a hone to bring up its edge. The others have not been touched.

THE MALLET AND OTHER INSTRUMENTS.

The mallet used by me is one of hard wood—lignum vitæ—with a hard wood handle.

The only other instruments used are an ordinary sharp-pointed scalpel, suitable for penetrating at once to the bone, and a couple of blunt hooks, which ought to be used very gently and sparingly.

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* The word "osteotome" has been previously applied to two instruments — a chain saw, and by the French to a pair of bone forceps. The term, as designating these articles, has long fallen into desuetude.

The manner of using the chisels and osteotomes is described further on. It is advisable that one wishing to use them should practise on the dead subject, or on the bones of animals, so as to familiarize the hand and acquire the necessary dexterity. A carpenter would not permit a fine piece of work to pass into the hands of one not thoroughly conversant with the use of his tools; how much more is it necessary that the surgeon should know the manner of handling his instruments and be cognizant of the principles on which they work.

CHAPTER IX.

GENERAL OPERATIVE REMARKS.

ANÆSTHESIA—RENDER THE LIMB BLOODLESS—SAND PILLOW—WOUND IN THE SOFT PARTS—MANNER OF USING THE OSTEOTOME—MANNER OF USING THE CHISEL—CLEANLINESS IN INSTRUMENTS.

ANÆSTHESIA.

THE patient ought to be placed fully under the influence of an anæsthetic before commencing the operation, as any voluntary movement of the muscles, while the incision in the soft parts is being made, may produce a larger lesion than necessary. Its effect ought to be fully sustained during the whole performance of the operation, as any movement of the limb, such as would be made by powerful muscular contraction, might alter the direction of the osteotome, when this instrument is inserted through a mass of muscle. It also ought to be kept up until the limb is placed in the desired direction on the splint, and the bandages applied.

RENDER THE LIMB BLOODLESS.

After the patient is fully anæsthetized, the limb is rendered bloodless. This may be effected in one of two ways. Either by taking advantage of the action of the vaso-motor system on the blood-vessels, called into play when the limb is held perpendicularly by its most distal extremity, and when thoroughly emptied of blood, which will occur in a few minutes, the limb is then encircled by elastic webbing, the first few turns being quickly applied at some inches above the part to be operated on; or by taking the elastic webbing, as used by Esmarch, and bandaging from the distal extremity of the limb to a point above that selected for the operation, and then fixing it in the ordinary manner. These two methods have been repeatedly compared on the same patient, Esmarch's on the one limb, Lister's on the other, each proving effective. The limb bandaged by Esmarch's method was, on the whole, the less vascular of the two, but there was little to choose between them. These remarks only apply to limbs in which there is no pus or obnoxious fluid which could be driven by the bandage into the vessels or into the surrounding tissues, as in such a case there could be no dubiety about selecting Lister's method. The amount of pressure generated by the elastic solid india-rubber cord is difficult to regulate; its force is much too concentrated, and bad effects are consequently apt to ensue, so that it is never used by me. The elastic webbing is applied by a greater number of turns which have a cumulative effect, and by its breadth the pressure is distributed over a greater area.

SAND PILLOW.

When the limb has thus been rendered bloodless, it is placed in a suitable position for the performance of the osseous section. When the osteotome, or chisel, is to be used, a firm resisting surface upon which to place the limb is necessary. The table itself would do; but when the lower limb is placed on its back in an extended position, with the fleshy part of the thigh and the calf of the leg resting on the table, a certain elasticity is present which meets the impulse of the osteotome with a rebound, which, though slight, is unpleasant, and renders the necessary force to be applied to the osteotome difficult of being measured. Blocks of wood fashioned to suit the limb, padded with sawdust cushions, are better, but a sand pillow * is in every way superior. The pillow commonly in use is eighteen inches by twelve, the case being filled with sand just full enough to enable it to be shifted from one part of the bag to another without leaving a portion empty —a moderate fulness without distension. The sand is moistened just before the operation, to prevent the escape of dust and to produce greater cohesion between its particles, so that it will more readily retain the form or mould imparted to it. It is then covered with a sheet of jaconet and laid on the table. The limb is then partially embedded in the pillow in the manner suitable for the particular operation. The pillow then affords a firm resisting surface, at once kindly to the limb, and effective as a support. Once the surgeon has experienced the comfort of using it, it is unlikely that he will substitute any other means at present at our disposal.

WOUND IN THE SOFT PARTS.

The wound ought to be a sharp, clean, single incision, produced by one stroke of the instrument. Avoid dissection. Choose well the situation in which the incision is to be made, and get to the bone as directly as possible. The direction of the incision depends on the situation. It ought to be made, other things permitting, in a line with the muscular fibres about to be penetrated. As the wound in the soft parts is often required to be made in quite a different axis to that of the osseous incision, it is advisable, while touching the bone with the scalpel, not to lean so heavily as to penetrate the periosteum. Further, when the osteotome follows the knife under similar circumstances, it is first introduced in a line with the incision in the soft

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* Suggested by Mr. Beattie, one of my clinical students.

parts, and must then be turned to the direction of the intended osseous incision: in so turning it must lean lightly on the bone, so as to prevent a portion of the periosteum being peeled or scraped up. Reference has been made to voluntary muscular movement, which may ensue if the patient is not fully under the anæsthetic, but there is also a manifestation of muscular irritability at the moment when the muscle is pierced by the scalpel. This muscular contraction is apt to be followed by a larger incision being made in the muscle than is intended, and it is further apt to alter the relation of the skin to the muscular wound. The former may be avoided by inserting the scalpel with its blunt back turned toward the direction from which the muscle contracts, so that the force generated by the muscular irritability will spend itself against the blunt back of the scalpel, the point of the instrument being steadied on the bone. On the other hand, if the incision be made quickly and the bistoury immediately withdrawn, the relative position of the skin and muscular fibres may be shifted by the muscular contractility, and the insertion of the osteotome may thereby be rendered difficult. It is therefore advisable to maintain the bistoury *in situ* as a guide to the osteotome until the latter is fairly inserted, when the bistoury is withdrawn. The situation of the wound in the soft parts ought to be selected so as to avoid cutting not only the larger vessels, but also the smaller ones when possible. Superficial veins, when seen, may even be avoided, as the whole size of the wound need not exceed half an inch to an inch, sometimes much less, according to the instrument and the surgeon's ideas. Some surgeons desire to see what they are doing, and they require a large wound. When performing my second osteotomy a wound was made in the soft parts sufficient to enable a view of the bone to be obtained; the following one was made large enough to enable the finger to be inserted, so as to feel what was being done; while the subsequent wounds were made of a size sufficient only to enable the osteotome to gain admission to the bone. In a short time the osteotome may be used as a probe, the sensations conveyed through the instrument being sufficient to enable the operator to ascertain all that could be known by the introduction of the finger. Consequently most wounds for simple section of bone are not more than half an inch to an inch in length, some less—according to the breadth of the instrument.

In removing wedges of bone, the wound must be larger. In removing wedges from the tibia, from which, indeed, wedges are almost alone required to be removed, the incision in the soft parts must not necessarily be greater than the base of the wedge to be removed, or even not so great, as the skin is freely mobile, and may be shifted up or down over the surface of the bone, so that it may be pulled upwards to enable the proximal incision to be made, and downwards when the distal is being cut. It is, however, much better to make a large wound than a small one, and to resort, in the latter case, to dragging the lips of the wound asunder with blunt hooks, and so tearing or bruising the tissues. For the beginner the larger wound is the easier and safer. It is much better to have a wound which is large enough to admit the finger, or even to enable the operator to see what he is doing, than to work in the dark. Once the tactile impressions conveyed through the instrument are sufficiently developed and the operator gains confidence, the wound may be reduced in size.

MANNER OF USING THE OSTEOTOME.

In those cases where the osteotome is to be used for simple incision in the bone, it ought, when the point to be penetrated is muscular or bulky, to be made to pass alongside of the scalpel, before removing the latter, after it has made the incision in the soft parts. When the osteotome has reached the bone it ought to be turned (without denuding the bone of periosteum by pressing too hard) to the direction in which the osseous incision is to be made. If there be any important soft structures close to the bone which it is necessary to avoid, the osteotome ought to be used in such a way as to direct its cutting-edge away from these. The osteotome having blunt sides, it may be used for the purpose of levering the soft tissues aside, keeping, meanwhile, the cutting-edge of the instrument in contact with the bone. In this way important structures may be pressed aside, and the edge of the osteotome directed from them. After a little practice, the osteotome acts as a probe, and when once the tactile impressions conveyed through this instrument are cultivated, it becomes a delicate indicator of the state of the bone, the precise relation of the osteotome to it, and the extent of the osseous division. But when the osteotome has been imbedded in the bone for an inch or two, its delicacy of touch is lost, and it no longer remains a precise indicator of what is in contact with its cutting edge. This is due to the manner in which the sides of the instrument are pressed on and caught by the bone, the amount of lateral pressure varying according to the density of the osseous tissue through which the instrument passes. This, however, may be easily rectified by introducing a finer instrument by the side of the thicker one first used, and withdrawing the latter. The finer instrument is then placed in the osseous groove made by the thick one, but, being a more attenuated wedge, its sides are not pressed on, so that it acts as an indicator of the kind of tissue in immediate contact with its cutting-edge. This can be repeated in a thick bone by the substitution of a third instrument of greater acuteness.

Before commencing to cut the bone, the precise position of the chisel in relation to the parts ought to be noted, so that it may be maintained in the same direction throughout. The lines making up the octagonal handle aid in this way. When this is noted, the instrument is then grasped firmly in the left hand, steadied by the inner border of the hand resting on the patient's limb. In this way the surgeon has complete control of the instrument, can guide it accurately, and instantly check any excessive impulse or prevent any deviation which might inadvertently be conveyed by the mallet. This is important, as the surgeon beginning to osteotomize is apt to hold the instrument loosely, such as between the finger and thumb, when a slightly uneven blow with the mallet outweighs the grip and may cause the chisel to slide along the surface of the bone, peeling the periosteum or occasioning some equally unpleasant accident. When the chisel is placed in position, the mallet may then be brought into requisition, being used by the right hand. When the external shell of bone is felt to have given way, it is not advisable to attempt at once to complete this particular portion of the section, because the instrument is then apt to be caught—impacted more or less. It is true that with the osteotome the base of the wedge is outward, and therefore it is more easily removed than an instrument having a shoulder like the carpenter's chisel; still it is better to avoid any tendency to impaction. This may be done by completing the entire superficial portion of the section in the first instance, so as to permit a little movement of the osteotome in the direction of its breadth—in the long axis of it, not at right angles to its breadth—and by making a series of such movements after each impulse given by the mallet there can be no fixity. The instrument may also be made to traverse the deeper layers in a fan-like manner, always keeping on the original lines, so as to cut in a sweeping manner across the bone, instead of making a series of punctures in it. When the surgeon wishes to withdraw the osteotome from the deeper parts toward the superficial portion of the bone, the instrument is often, much to the surgeon's annoyance, pulled not only to the surface of the bone, but also out of the wound in the soft parts. The lips of the wound then require to be held aside, the instrument reintroduced, and the osseous gap sought for. In order to avoid this inconvenience, the instrument, instead of being pulled out of the incision, ought to be levered up, which may be effected by an alternate contraction and expansion of the hand, regulated in the following manner.

The hand being loosely closed round the osteotome, without actually touching it, its ulnar border is pressed closely down on the limb, the instrument is then firmly grasped between the index, mid-finger, and the thumb, when an elevating force, due to the expansion of the palmar muscles, is obtained by tightly closing the remaining fingers. This being exhausted, the procedure may be repeated. In this way the elevation of the instrument may be regulated with precision.

The osteotome or chisel ought not to be pressed against the bone transversely to its breadth, as it is possible that it may be broken or twisted by so doing. The bone itself may be splintered longitudinally by such pressure. The soft bones of children may yield sufficiently to prevent any of these accidents occurring, but the pressure of the instrument transversely to its breadth even here is quite unnecessary and useless.

MANNER OF USING THE CHISEL.

The chisel is used for the excision of wedge-shaped or cuniform pieces of bone. The osteotome could be used for this purpose, but the chisel answers very much better. When the size of the wedge to be removed is predetermined, the length of the base is measured on a pair of calipers, which, when properly carbolized, may be applied to the osseous surface, and thus serve as a guide. In cutting the bone with the chisel, the straight edge ought to be kept toward the part of the bone which is to remain in the body, the bevelled edge toward that to be removed. When a large wedge is to be cut out, it is better to remove it in several pieces; first a small superficial wedge, then a shaving off each side, until the desired extent is reached. If an attempt is made to remove a deep wedge from a thick bone in a single piece there is considerable difficulty experienced, by the tendency which the chisel has of inclining towards the straight edge, especially after the whole of the bevelled surface has been imbedded in the osseous tissue. Another reason for not removing the whole wedge in one piece is, that by adopting a contrary method the sides of the cuniform opening may be more accurately and evenly pared by shaving the bone. For these reasons the larger wedges ought to be removed piecemeal. It is, perhaps, needless to say that the edge of the chisel must not project beyond the edge of the bone, otherwise the soft structures may be encroached on. The form of the normal bone, as it appears in sections, may be of some aid in guiding the direction of the osseous incision; but this cannot be absolutely depended on in the case of distorted bones, as their contour is often greatly altered. It may be remembered that they have a tendency to flattening, sometimes in one direction, sometimes in another, and that when the bone is curved the concave portion has the thicker walls. As the tibia is the bone which almost exclusively requires cuniform osteotomies performed on it, it is so superficial on the inner side, that its particular form may be well made out. If the precaution be taken to cut on the inside of the periosteum, it gives a surety that the soft tissues beyond are not injured. It is also of importance to remember the same precaution here, as in the case of the osteotome, not to place pressure on the chisel transversely to its breadth. When this is resorted to in order to lever up the portion of bone cut, the bone is apt to split. If the bone is hard, and the chisel has a very keen edge, it is apt to be snapped. Besides, the movement is not necessary, and may well be avoided. In many cases it is advisable not to include the entire diameter of the bone, but so to form the wedge that a portion of the deformity is rectified by its removal, allowing the remainder to be made up by a small hiatus left on the opposite side. In doing this the apex of the wedge need not penetrate further than three-fourths of the diameter, the remainder may be snapped.

CLEANLINESS IN INSTRUMENTS.

One might have thought it unnecessary to state that the instruments ought to be kept scrupulously clean, but I am persuaded that this is not sufficiently attended to. The surgeon ought to see to it with *his own* senses. If the osteotomes or chisels are not thoroughly clean before being used, they will be cleaned by contact with the bone, and so impregnate the osseous tissue with foreign matter, which may be highly detrimental and even dangerous. If the operator desire to introduce his finger into the wound, it ought to be perfectly clean and previously rendered antiseptic. These remarks apply equally to all appliances used during the operation and subsequent dressing. The sponges ought to be employed for fresh wounds only; those used for decomposing wounds ought not to be brought near a fresh wound.

CHAPTER X.

OSTEOTOMY FOR OSSEOUS ANCHYLOSIS OF HIP-JOINT.

CASES SUITABLE FOR THE OPERATION—FORCIBLE STRAIGHTENING NOT FREE FROM DANGER—INTER-TROCHANTERIC OSTEOTOMY—DIVISION OF THE NECK OF FEMUR SUBCUTANEOUSLY—INFRA-TROCHANTERIC OSTEOTOMY—ANTISEPTIC DIVISION OF NECK OF FEMUR.

CASES SUITABLE FOR THE OPERATION.

Osteotomy is applicable when the head of the femur is fixed by osseous anchylosis, and the lower limb is raised to an angle with the pelvis sufficient to prevent the foot from reaching the floor. There are cases of hip-joint disease, which result in osseous anchylosis, the limb being rendered useless for walking or standing. These may originate in what is known as strumous disease, or in rheumatic arthritis, the anchylosis of the latter being accompanied by deposits of bone of various forms round the neck of the femur. Besides these, there are cases of long standing, unreduced dislocations, in which the head of the bone has become fixed to the pelvis by osseous anchylosis in such a manner as to render the limb unfitted for use. In such cases the osteotomies about to be mentioned may be performed.

FORCIBLE STRAIGHTENING NOT FREE FROM DANGER.

Forcible straightening used to be employed for the purpose of reducing anchylosis of the hip, even in those cases where there was osseous union, and it is still used by some surgeons. It is a method which has been successful in many instances, but it must be remembered that its application is not without danger, as serious consequences have at times arisen from its use. On one occasion a case came under my observation, in which a surgeon reduced an old standing anchylosis by the employment of considerable force, which resulted in death after a few hours, with symptoms of internal hæmorrhage and collapse. In another instance a portion of the ilium was fractured during the attempted straightening. These results would probably have been avoided had osteotomy been performed.

INTER-TROCHANTERIC OSTEOTOMY.

The first operation for the relief of anchylosed hip-joint by what may be termed osteotomy was performed by Dr. J. Rhea Barton, in 1826. This he did by making a large open wound in the soft parts, then applying the saw between the trochanters and afterwards straightening the bone. Dr. Lewis A. Sayre, in 1862, removed a transverse plate of bone between the trochanters, also by an open wound. In 1852 Langenbeck performed subcutaneous osteotomy for anchylosis of the hip-joint, by first perforating the bone by a drill a quarter of an inch in diameter, then passing through this aperture a narrow-pointed saw, an eighth of an inch wide at the distal extremity, and four inches long; with this he divided the bone until the shell on the further side was reached. This was snapped, and the limb was straightened.

DIVISION OF THE NECK OF FEMUR SUBCUTANEOUSLY.

Mr. Adams, in 1869, performed subcutaneous osteotomy at the hip. The instruments he used were a tenotomy knife, a quarter of an inch in width, mounted on a long handle, and a small saw more than a quarter of an inch in width, with a cutting edge an inch and a half in length, at the end of a blunt shank three inches in length. Mr. Adams thus describes his operation*:—"I entered the tenotomy knife a little above the top of the great trochanter, and carrying it straight down to the neck of the thigh-bone, divided the muscles and opened the capsular ligament freely. Withdrawing the knife, I carried the small saw along the track made—preserving this by pressure of the fingers of the left hand—straight down to the bone, and sawed through from before backwards." At first attempts were made to establish a false joint, but bony anchylosis in the straight position set in, and the man was enabled to follow his usual avocation. Mr. Adams has collected and recorded twenty-two cases in which this operation has been performed.

INFRA-TROCHANTERIC OPERATION.

When the head of the bone has been destroyed, or where there is in anchylosis following rheumatic arthritis, an exuberant deposit of new bone forming hard nodules or spicula round the femoral neck, Mr. Gant proposes the division of the shaft of the femur subcutaneously, just below the small trochanter; instruments being used similar to those of Mr. Adams, the saw, however, having a longer cutting edge and a thinner blade. Mr. Gant † performed this operation in 1872. In 1875 Mr. Maunder performed a similar operation, using Volkmann's chisel instead of the saw. Volkmann ‡ removed a wedge from the femur below the trochanter in two cases of extreme contraction of the hip in 1874.

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* "British Medical Journal," Oct. 18, 1879, p. 605.

† "Lancet," Dec. 1872; also see "British Medical Journal," Oct. 18, 1872.

‡ Volkmann: "Centralblatt für Chirurgie," No. 1, 1874.

ANTISEPTIC DIVISION OF NECK OF FEMUR.

An antiseptic osteotomy was performed by me in a case of dislocation of old standing, the limb having assumed a position which rendered it useless. The man was forty-two years of age, and had received a dislocation of the head of the femur twenty-eight years previously. When standing erect the right heel was nine inches from the floor, the thigh forming with the leg an angle of 40°. The head of the bone was felt on the dorsum of the ilium, near the ischiatic notch. On July 7th, 1879, an incision, about an inch and half in length, was made over the neck of the bone, the finger was introduced, the acetabulum explored, and found to be filled with some firm material, the head of the bone being united to the ilium by osseous union. An osteotome was then introduced, the neck of the femur divided by a few strokes, and the limb brought round straight. Three weeks afterwards, the limb, which was then looked at for the first time, was found healed—the thin, shrivelled layer of blood clot peeling off, leaving an epithelial covered surface underneath. On August 5th he was allowed to leave his bed and to walk with crutches. A slight amount of motion was established at the hip, and he was soon able to walk easily with a stick, a cork sole, about an inch in thickness, being supplied. The patient had no pain at any time, and his temperature never rose above normal.

Mr. Adams and Mr. Gant performed their operations subcutaneously, and they have met with very considerable success. Though the wound in my case was only an inch and a half in length, it was sufficient to admit the introduction of the finger to explore the position of the parts, the condition of the acetabulum, and nature of the attachments of the bone, so that it could not be classed as a subcutaneous wound, but as an antiseptic osteotomy.

CHAPTER XI.

OSTEOTOMY FOR OSSEOUS ANCHYLOSIS OF KNEE.

CASES SUITABLE FOR OPERATION—HISTORY OF OPERATION—MODE OF OPERATING—ILLUSTRATIVE CASES.

CASES SUITABLE FOR OPERATION.

Osteotomy is indicated in the treatment of contractions of the knee-joint, where such deformity exists as to render walking or standing difficult or impossible, and where forcible straightening cannot be practised with safety. When there is firm osseous union of the tibial head with the femoral condyles, or where the patella is fixed by osseous union to the tibial portion of the femoral articulation, posterior tibial contraction existing in both cases, forcible straightening is often impossible, and when it has been attempted it has sometimes been followed by serious results. There are cases where the head of the tibia is fixed to the posterior part of the femoral condyles in a state of subluxation, and where, if forcible extension is resorted to, more or less complete dislocation may result, ending in a useless limb. Volkmann[*] has also called attention to another condition which comes on, where the angular contraction commences in childhood, and where it persists till puberty. "It consists of a prolongation of the condyles of the femur in the direction of the long axis of the bone, and it is brought about by the overgrowth of the lower part of the articular surface, because it has been released from the pressure of the head of the tibia, and from the weight of the body in walking, as a result of the permanently flexed position of the joint. A longitudinal section of the condyles of the femur assumes, in consequence, the shape of a long ellipse." In this state, though the articulation may remain, yet the lateral ligaments are so shortened as to prevent anything like straightening of the limb being effected with a good result. Osteotomy, in such cases, offers an easy and safe remedy.

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[*] Volkmann: "On Antiseptic Osteotomy."—"Ed. Med. Journal," March, 1875.

HISTORY OF OPERATION.

In 1835, Dr. J. Rhea Barton operated by open wound, performing an osteotomy for the reduction of an anchylosed knee-joint. In 1844, the operation of Dr. Barton was modified and extended by Dr. Gurdon Buck, of New York, who, in a case of complete synostosis of the knee, removed the condyles of the femur, the head of the tibia, and the patella, in a wedge-shaped piece, thereby bringing the leg into an almost straight position. This, however, may be regarded as an excision of the knee rather than an osteotomy. Langenbeck performed subcutaneous osteotomy for anchylosis of the knee-joint in 1852. Mr. Stromeyer Little* operated, on November 11th, 1868, on a case of bony anchylosis of the right knee-joint, driving a strong carpenter's chisel through the united bones in several directions. Langenbeck's and Little's operations were done subcutaneously; in the latter instance the wound healed by first intention, and in three weeks the patient walked on crutches. The first antiseptic osteotomy for anchylosis of the knee-joint was performed by Volkmann, of Hallé, in August, 1874. In April, 1875, I operated antiseptically on an anchylosed knee-joint—the first antiseptic osteotomy in Britain—the wound healing by organization of the blood clot. In December, 1876, Mr. Barwell,* in a case of anchylosed knee, divided the femur much in the same way as Volkmann did, he also performing his operation antiseptically.

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* "Medico-Chirurgical Transactions," vol. liv. p. 247. Longman, 1871.

MODE OF OPERATING.

In some instances of anchylosed knee-joint, the deformity may be rectified by a simple division of the femur; in others the angularity may be so great that the tibia may require division as well as the femur. In operating on the femur, the most suitable position for the wound in the soft parts is one or other side of the rectus tendon—some prefer the outer side—on a level with a line drawn transversely, a finger's breadth above the upper portion of the external condyle. A wound sufficient to admit the osteotome ought to be made here in a longitudinal direction (not transversely, as is advised) down to the bone; the osteotome is then introduced longitudinally, then turned transversely; the femur is cut for fully two-thirds of the thickness, and the remainder bent or snapped. The operator ought to remember that the external aspect of the bone is here thicker and stronger than the internal. When a supplementary operation on the tibia is necessary, the place selected is just below the anterior tubercle. A wound a little larger than the osteotome is made over the anterior tibial ridge, and the tibia is divided transversely. In dividing the tibia here, the instrument may be made to pass from the anterior surface over the inner side of the tibia to the posterior surface, directing the instrument, while so doing, from within outwards, so that the dense shell of bone on the inner side of the tibia may be divided; this renders the subsequent section easy. The fibula does not require to be divided, but in cases of long standing the hamstring tendons may require tenotomy before the straightening can be completed.

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* Mr. Richard Barwell's "Clinical Lectures."—"Brit. Med. Journal," April 28, 1877.

ILLUSTRATIVE CASES.

I have generally operated by the femoral incision alone, but in one case, where the knee was bent to quite a right angle, the tibia had also to be divided. The woodcut represents a moderate degree of deformity resulting from anchylosis of the knee. It occurred in a girl sixteen years of age, formerly the subject of strumous disease of the knee-joint, after which the knee became contracted, and remained so for several years. When admitted, osseous union was complete between the femur and tibia. The tibia was thrown well to the posterior borders of the femoral condyles, and these latter structures had the elliptoidal form, which they are apt to assume when the pressure of the weight of the body has been long removed from their extremity. In this case the condyloid increase amounted to fully an inch greater than the condyles of the neighbouring limb. When the knees were placed together as the patient stood, the toes of the affected limb were two inches, and the heel seven inches, from the floor. Osteotomy was performed as described, the incision in the soft parts being made to the inner side of the rectus tendon. The wound healed by blood clot organization.

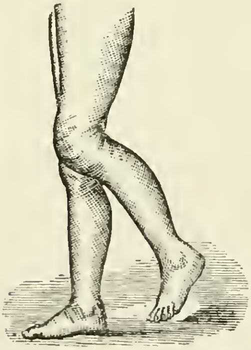

Fig. 15.—Osseous Anchylosis of Knee—Angular Deformity.

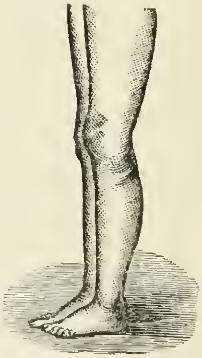

Fig. 16.—Result after Osteotomy.

In six weeks she was dismissed with a straightened limb, as shown in Fig. 16.

The tibia was divided, as well as the femur, in a case of anchylosis, where the limb was bent to quite a right angle.* He was twenty-two years of age, and sixteen years previously he began to suffer from "white swelling" of the knee, for which he was treated. Four years after, the joint having suppurated, he became a patient in the Royal Infirmary, where he was advised to have his limb amputated. To this he did not agree. He was afterwards a patient in the Belfast Infirmary, where he remained for some weeks, and was dismissed as incurable. He walked with a crutch, though the limb was flexed to quite a right angle, and united firmly by bone. It was resolved to osteotomize above and below the joint, which was done on August 2nd, 1879, and the limb straightened. A fortnight after the wounds were looked at for the first time, and found healed. On September 17th he was allowed to walk about. His knee-joint was prominent anteriorly, but the bones were firmly united, and the limb was straight. There was about an inch of shortening, which only enabled him to clear his toe from the floor in walking. A year after he reported himself at the hospital. He had been in regular employment as a van driver since dismissal. He had to go up and down the steps of the van many times daily, and did so without inconvenience.

Though most of the cases of angular anchylosis of the knee are the sequelæ of diseased conditions, yet the same deformity may result from injury. In one case (a patient twenty-six years of age), having a traumatic origin, the limb was straightened by me with a very satisfactory result.

Six cases of anchylosis of the knee have been osteotomized by me with a uniform result—wounds healing by vitalization of blood clot, without pus formation, the limb being straightened, and the bone firmly uniting.

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* Abstracted from the reports of Dr. J. Wallace Anderson in "Glasgow Medical Journal," Oct. 1879.

CHAPTER XII.

GENU VALGUM—TREATMENT OTHER THAN OSTEOTOMY.

GENERAL TREATMENT WITHOUT OPERATIVE MEASURES—SUBCUTANEOUS FIBROUS SECTION—"METHODE DE REDRESSEMENT FORCÉ."

GENERAL TREATMENT WITHOUT OPERATIVE MEASURES.

The question whether knock-knee undergoes "spontaneous" cure as the young patient grows older is often asked, and there can be no doubt that cases have occurred during childhood, when the deformity, though at one time marked, has undergone rectification without operative interference. In my own practice there have been a few such cases, the genu valgum ensuing after a debilitating disease, occurring during childhood, and when the deformity was early recognized and promptly treated. It is necessary to inquire what the circumstances are which permit and tend to promote the disappearance of the deformity. Attention to four points will materially assist the solution of this question: the state of the bones, the extent of the deformity, the cause of the bodily weakness, and the removability of the physical cause of the deformity. If the bones are still in a soft condition, even in a state of *ramollissement* if the deformity is not aggravated, if the cause of the constitutional enfeeblement is remediable, and if the physical cause of the deformity can be effectually removed, there is a probability that the bones may, through time, assume their normal form under proper care and treatment. The treatment must be directed towards improving the general health and increasing the strength by an abundant supply of pure air, good food, cod-liver oil, and tonics. Until the strength has been fully established, the weight of the body must not be supported by the limbs.

Regarding this last item, the problem to be solved is, how to exercise the limbs so as to maintain their development, and at the same time prevent the weight of the body from resting on them. The child ought not to be allowed to stand or walk unsupported. He may be allowed to play while sitting or lying on a couch, or bed on the floor; but there is something more wanted. He requires fresh air and exercise other than a mere drive in a perambulator. If a scarf were placed round his body under his arms and held by a nurse, so as to support the greater part of the child's weight, the patient might enjoy a walk without detriment. In the house an elastic band suspended from the roof and attached to a suspensory apparatus, so adjusted as to permit the feet of the child to rest lightly on the ground, enables a considerable amount of exercise without permitting the weight of the body to press too heavily on the limbs. Then there are various wheeled contrivances which permit the weight of the body to rest on them, while the child pushes the machine before it. There are also light pedomotives, which afford a comfortable seat, and which may be easily driven by the child, either inside or out of doors. There are many other contrivances which will easily suggest themselves; the great point to be kept in mind is, that the weight of the body must not be allowed to rest entirely on the limbs.

Splints have been advocated. They are applied in such a manner as to draw the knee outwards, many adopting an outside splint with elastic bands over the knee. Extension has also been employed alone and in conjunction with various splints. Good results, in isolated cases, are spoken of as having occurred; personally I have not seen any. On the contrary, many patients have stated that they had been, at some previous period, subjected to the recumbent position, and the application of splints, which were retained continuously for months—one person for over six months—and they invariably stated that they were in no way benefited thereby. The limbs were sometimes straightened while the patient lay in bed, thereby inspiring a hope, which was dissipated as soon as they attempted to walk or stand, the deformity assuming its old or even a more aggravated position. Of course it may be said, and no doubt with justice, that these were not suitable cases for such treatment. The mere retaining of the patient in the recumbent position for months, exercises such a depressing and debilitating influence that something more than what appears to result from this treatment would require to be forthcoming, before it could be justified.

This seems to be the experience of Continental surgeons also. Dr. Delore states that he has treated knock-kneed patients in hospital with various splints and the best appliances, kept constantly under observation, in many cases for over six months, without the slightest benefit being derived. Some cases have been kept in splints in Vienna from five months to two years, with comparatively little benefit.

Again, there are various kinds of supports worn while the person goes about, which are serviceable, provided they are made so as to be applied with comfort to the patient. As a rule, they are too heavy and cumbersome to be long worn; the patients very often fret and soon discard them.

Once the bones have reached the stage of eburnation, these appliances are worse than useless, as they not only do no good, but time is wasted during which the deformity is developing; secondary osseous deposits are forming, which render the case more difficult to treat, and the deformity more difficult to remove.

SUBCUTANEOUS FIBROUS SECTION.

The section of the biceps tendon was first performed for the relief of genu valgum by Bonnet (Lyon), but it is right to say that Bonnet afterwards repudiated this measure as a means of curing knock-knee; for in 1841 he wrote, in his treatise on subcutaneous tenotomy, "Section of the biceps tendon facilitates the *redressement*, but it does not permanently effect a cure, as it is soon destroyed by walking. Of all the cases on which I practised the operation it is impossible to cite a single instance in which a success ultimately resulted." Again, no less a surgeon than Langenbeck, considering that the external lateral ligament was contracted, and that this was the cause of genu valgum, proposed and carried out its division, and this was repeated by Billroth. The latter operated on adults, the first two of whom recovered, with a good result; a third was incompletely rectified, and had free lateral movements in the joint; a fourth had complete paralysis of the right limb, and partial paralysis of the left, with lateral movements in the knee-joints, which rendered walking impossible without the assistance of orthopædic apparatus.

On one occasion I had the opportunity of seeing a case of a boy, seven years of age, on whom the division of the biceps tendon had been practised, and the result was by no means satisfactory, the limb being much in the same state as it was prior to the division of the tendon. The parents brought him to me, with the object of having the deformity rectified by osteotomy.

Billroth has likewise performed division of the external lateral ligament, along with that of the biceps, and a loose knee-joint resulted, which was followed by dry arthritis.* Mr. Jackson, Wolverhampton,† proposed and practised the division of the soft structures on the outside of the joint. Mr. Reeves divided the biceps, the external lateral ligament, and the fascia lata.* Mr. Brodhurst likewise divided the tense ilio-tibial band, the biceps tendon, and the external lateral ligament, and he states that after considerable experience of this procedure he has reason to be satisfied with the results. In a case which was shown by Mr. Brodhurst at the Clinical Society, London, in June, 1879,† in which this treatment was adopted, it was stated that the patient could not walk without crutches and orthopædic appliances, and some of the members of that society did not seem at all satisfied with the result, one of them‡ stating, in a subsequent paper, that it was forcibly proved to all present at the meeting of the Clinical Society in June, that the method which Mr. Brodhurst advocated was worse than useless.

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* Langenbeck's "Archiv," 1879, vol. xxiii.

† "British Medical Journal," Sept. 28, 1878.

Langenbeck thought that the void left by the separation of the tibia from the external condyle was soon filled up by hypertrophy of the external condyle and the gradual atrophy of the internal. It must be remembered that the external condyle and the tibia would come in contact with one another as soon as the person stood or walked, the void consequently would then be obliterated; on the other hand, as long as the patient remained in bed there would be no pressure on the internal condyle, which would not become spontaneously atrophied.

These procedures have evidently originated from a want of clear appreciation of the pathological conditions of genu valgum, the ligaments and tendons not being, as they supposed, the cause of the deformity, their shortening and contraction being only the result of an osseous deformity, without the remedy of which any fibrous section would be unavailing. Nor is the division of these structures accomplished without risk, the external popliteal nerve having been divided, resulting in some instances in permanent paralysis, and in others in temporary inconvenience. The ligaments on the outside of the joint having been divided, the joint has in some cases been rendered loose, and the individual been doomed to wear orthopædic apparatus, or to resort to the use of crutches, during the remainder of his life.

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* "British Medical Journal," Sept. 21, 1878. † "Lancet," June, 1879.

‡ "British Medical Journal," Oct. 18, 1879.

METHODE DE REDRESSEMENT FORCÉ.

The method of *redressement forcé*, as applied to genu valgum, was a distinct advance, as it sought to rectify the deformity by attacking the pathological osseous lesion. This method, which was at first applied to the rectification of mal-united fractures and anchylosis, was extended by Guérin to the adjustment of rachitic curves, under the heading of *ostéoclasie manuelle*, while Rizzoli introduced his *ostéoclasie mécanique*, which effected the straightening of the limb by mechanical instruments instead of the hand. Bardeleben used in genu valgum an apparatus consisting of two cylinders united by lateral bands, which was fixed to the limbs during flexion, when the tibiæ and the femora assumed a straight line. The limb was then extended, the instrument meanwhile retaining its fixed position, thereby forcing the limb into a straight line. M. Delore has applied and carried out *ostéoclasie manuelle* in genu valgum. As this procedure has been much practised by M. Delore and our Continental neighbours, a few facts concerning it are here introduced. There are various positions in which the patient may be put in order to practise *ostéoclasie manuelle*. M. Delore places the fully-anæsthetized patient on the side to be operated on, then exercises pressure on the apex of the knee, the thigh and external malleolus resting on the table. M. Taillaux lays the patient on the opposite side to that which is to be rectified, assistants fixing the pelvis and the thigh; the apex of the knee is supported, and the deformity is rectified by acting on the legs as a lever. This *redressement* is accompanied by the emission of a series of cracks, distinctive notes being produced as the ligaments, periosteum, and epiphysis are torn off; sometimes a very distinct snap follows the complete division of the bone. König prefers to perform *ostéoclasie manuelle* by a series of *séances*, maintaining by a plaster apparatus what he has gained at each sitting, much in the same way as many German surgeons rectify talipes. It is stated that in infants the deformity may be rectified by seizing the thigh in one hand, the leg in the other, and pressing the thumbs against the apex at the knee. The length of time necessary to effect this operation is stated by Delore to be from five minutes to half an hour, and sometimes eight assistants have been required to effect the *redressement.* When the limb is straightened, it is put up in plaster or glass bandage, for six weeks to two months, after which a simple splint and bandage is substituted. In the majority of cases, where this method has been practised, a slight febrile reaction follows, and a little pain during the first few days. On removal of the fixed apparatus, the knee is found more or less stiff, but the employment of *le massage* and gradual movements dissipate the stiffness. Crutches are used for a considerable time after, and it is necessary to watch the application of supports during the first year. Out of 200 instances occurring in M. Delore's practice there has been only one death, which resulted, not from the operation, but from scarlet fever. There have been some cases of sub-acute arthritis and other affections of the knee-joint. Billroth had some cases of *redressement forcé*, where partial paralysis of the external popliteal nerve occurred; while J. Bœckel had, after *redressement forcé*, a separation of the periosteum, followed by suppurating periostitis of the femur. Delore has nearly always operated on children, and one can understand that the *ostéoclasie manuelle* might be practicable in the stage of *ramollisement*, while the bones are soft and would be more apt to yield than the ligaments. On one occasion this method was practised by me on a boy aged five years, and after much difficulty the limbs were rendered tolerably straight, by what appeared to be a separation of the femoral epiphysis. The difficulty of effecting this was much greater than the performance of osteotomy, and the result was not so good as that obtainable from osteotomy of the femoral diaphysis. M. Delore fixes the age of eighteen years as the limit within which the method can be practised, but this is considered very much beyond the age at which the method can be practised with safety, as it must be very difficult and even hazardous to attempt it after eburnation has set in. Volkmann tried to do so in one instance and failed. On two occasions I attempted to straighten the limbs of persons about twelve years of age by *ostéoclasie manuelle* and failed. It is true, however, that the united force of a number of assistants was not employed. While favourable results are obtained in the child, the practice of the method in the adolescent presents quite another aspect. Out of 26 limbs—13 operated on by Billroth, 1 by Guérin, and 12 related in the Thesis of Saurel, Barbarin, De Santi, Vergues, and Aysaguer—8 were perfectly rectified, 7 incompletely so, 2 were followed by subacute arthritis, and 9 had lateral movements to such a degree as to render walking very difficult.

What is the lesion which ensues in *ostéoclasie manuelle* as applied to knock-knee? This question has been investigated by MM. Saurel, Barbarin, and Barbier, who practised this method post-mortem, on the bodies of infants, fifteen months to two years. They found that the femoral epiphysis separated in 7 instances; the femoral and tibial in 2; separation of the tibial alone in 3; and in 3 there was rupture of the external lateral ligament. The few clinical facts recorded by Billroth tend to corroborate the lesions thus produced in infants, showing the greater proneness for the epiphysis to separate than for the ligaments to rupture. In the adolescent it is just the reverse. De Santi experimented on the *cadavere* between eighteen and twenty years, and obtained 12 facts. In 9 there was a rupture of the external lateral ligament; in 2 a portion of the external condyle gave way; and in 1 there was an articular fracture of the condyle. These again are supported by clinical facts obtained by the practice of *redressement forcé* in the adult, as in 14 there was a rupture of the external lateral ligament, and in 1 the femoral condyle was fractured.

It is thus seen that a tearing of the epiphysis of the femur or tibia, or both, may happen in *redressement forcé* practised among children, and sometimes even in them there is a rupture of the external lateral ligament. In the adolescent the external lateral ligament is most frequently ruptured, and, as a rule, it results in a permanent loose joint. As the liability to rupture the external lateral ligament increases as the age advances, the results of *redressement forcé* are consequently better the younger the patient is. The fear of the arrest of growth of the bone by the separation of the epiphysis is not borne out by the results. This is explained by Barbarin, who states that the fracture takes place at the distal extremity of the diaphysis, the epiphysary cartilage remaining attached to the epiphysis, and so furnishing it with nutrition.

In conclusion, then, *ostéoclasie manuelle* is only applicable to children in whom the bones are still soft. In the adolescent, it is apt to produce a worse condition than the deformity which it seeks to relieve. In either case it is vague and uncertain in its action; it may produce a tearing of the epiphysis of the femur, or tibia, or both, or neither; sometimes there may be a fracture of the condyles, often a rupture of the external lateral ligament; in fact, no one knows before the operation is completed what particular lesion this unwieldy force may effect! Had this operation been performed in non-antiseptic days, it would have had an advantage over any cutting operation, inasmuch as, it would be a simple fracture or lesion—one not exposed to the air. But an antiseptic osteotomy may be regarded as a simple fracture or incision, and therefore it is quite on a level, in this respect, with *redressement forcé*. Granting this, there is the fracture of the bone, at haphazard, with probable rupture of the external lateral ligament, which one has in *redressement brusque*, compared to the division of the bone with mathematical accuracy, afforded by the chisel. The after results of *ostéoclasie manuelle* offer no advantage, the patient being kept up longer in splints, and the after recovery being more protracted. It may be safely concluded that *ostéoclasie manuelle*, or *mécanique*, has served its time, and cannot be practised in the presence of the more exact methods of the present day.

CHAPTER XIII.

GENU VALGUM—OSTEO-ARTHROTOMY—THE SEPARATION OF THE INTERNAL CONDYLE OF THE FEMUR.

VARIOUS OPERATIONS PROPOSED FOR SEPARATION OF THE INTERNAL CONDYLE OF THE FEMUR—THE DEFECTS OF THE SEPARATION OF THE INTERNAL FEMORAL CONDYLE AS A CURE FOR GENU VALGUM.

VARIOUS OPERATIONS PROPOSED FOR SEPARATION OF THE INTERNAL CONDYLE OF THE FEMUR.

The ideas formerly prevalent regarding the pathology of genu valgum were such as to direct almost exclusive attention to the internal condyle, and to look upon its elongation as the sole factor in the deformity. It is probably owing to the prevalence of this idea that so many operations have been proposed for the separation of the internal condyle. Our Continental neighbours, regarding the separation of the internal condyle as necessarily involving the opening of the joint, include all such operations under the title of osteo-arthrotomy, and practically the title is deserved.

The first operation which had the object of attacking and reducing the internal condyle was performed by Professor Annandale, of Edinburgh.

On March 16th, 1875, he opened the joint, in a case of genu valgum,* by a longitudinal incision on its inner side; the lateral and crucial ligaments were divided, and a somewhat cuniform slice was sawn from the internal condyle, a small portion of bone being likewise removed from the external condyle. This operation was performed antiseptically, and though the limb was straightened it became anchylosed. A somewhat similar operation was repeated by Mr. Howse.* Professor Annandale does not now advocate it, and has not again performed it, preferring some of the other methods since advanced. This operation may with propriety be regarded as a partial excision of the knee-joint rather than an osteotomy, in its restricted sense. Fig. 17 represents the line of incision across the condyles used by Professor Annandale in the above case.

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* "Edinburgh Medical Journal," vol. xxi. p. 18.

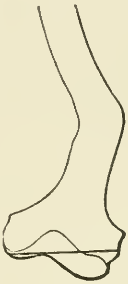

FIG. 17.—LINE OF INCISION USED BY ANNANDALE.

About a year after this, the practicability of separating the internal condyle was by a stroke of genius demonstrated by Ogston, of Aberdeen. It was the first practical osteo-arthrotomy, and has been the basis of the other methods of separating the internal condyle since advanced. His first operation was performed on May 17th, 1876.†

He uses an Adams's knife and saw. In performing the operation the knee is flexed as fully as possible; a long tenotomy knife is introduced flatly, two or three inches above the tip of the inner condyle, and pushed downwards, forwards, and outwards, until the point is felt in the intercondyloid space. The cutting edge of the tenotome is then turned downwards, and the soft tissues are divided to the bone, as its withdrawal is effected. Adams's saw is then introduced along the groove formed by the knife, and the inner condyle is sawn through from above downward, for about three-quarters of its thickness. The fracture is completed by forcibly straightening the limb, the loose condyle slipping upward over the sawn surface.

It was manifest that the operation was practicable, and the probabilities of success were such that it deservedly became popular, and was quickly repeated by surgeons in

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* "Guy's Hospital Reports," 1875.

† "Edinburgh Medical Journal," March, 1877.

Britain and Germany, with most gratifying results. Mr. Barker states that out of forty-five published cases collected by him he finds only one death clearly traceable to the operation;[*] this person dying forty-eight hours after, from well-marked septicæmia. Since that time there has been another death reported of septicæmia following Ogston's operation.[†]

Fig. 18 shows the line of incision used by Ogston in sawing off the internal condyle of the femur; and Fig. 19 represents the same limb, after the condyle is detached and pushed up on straightening the limb.

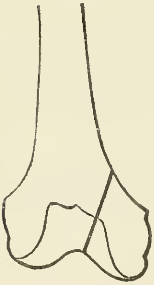

Fig. 18.—Division of Internal Condyle—Ogston's Line.

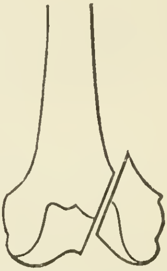

Fig. 19.—Separation of Internal Condyle—Result on Straightening the Limb.

Instead of performing the operation subcutaneously, Schmitz, of St. Petersburg,[‡] thinks that Ogston's procedure may be more accurately carried out if a larger wound be made, which would enable the eye to see what is being done: this open wound at the same time allowing free vent for discharge. He quotes the case of a girl, sixteen years of age, who was submitted to this operation with good result. He also proposes to perform this operation non-antiseptically. It will be interesting to know the result of his first twenty cases thus treated.

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[*] Mr. Barker: "Operations for Genu Valgum contrasted."—"British Medical Journal," July 5, 1879, p. 2; also, see "Lancet," Nov. 16, 1878, for notes of case; also, in "Transactions of Clinical Society of London," 1879.

[†] "Centralblatt für Chirurgie," No. 3, 1880.

[‡] Ibid. April, 1879.

A more important modification of Ogston's method was performed by Mr. Reeves at the East London Children's Hospital on March 17th, 1879.*

Mr. Reeves proposed the separation or loosening of the internal condyle with a chisel, instead of a saw, and his aim is not to open the joint. He penetrates the condyle to its greatest depth, *but only as far as the cartilage covering it.* Instead of separating the condyle with the chisel he merely loosens it, and the separation is completed by the forcible straightening of the limb. Mr. Reeves has operated principally on children, and it is quite possible that in them, when very young, the cancellated tissue of the condyles may be in such a soft, spongy state as would enable the internal condyle to be compressed to a sufficient extent by *redressement forcé* to rectify the deformity without opening the joint. But under such circumstances, it may be questioned whether *redressement forcé* might not in itself be adequate to rectify the deformity without any other procedure. In the child whose bones are eburnated, in the adult, and in those instances where the deformity is great, the joint will be opened, either by the chisel or by the snapping of the articular cartilage, when the limb is attempted to be straightened and the internal condyle pushed up. De Santi † has several times performed Reeve's operation on the subject, but never succeeded in obtaining an abduction of 30° without tearing the diarthroidal cartilage, and consequently opening the joint.

Post-mortem experience in the adolescent shows me, that it is extremely difficult to divide the bone down to the articular cartilage, without permitting the chisel to pass through or rupture that structure, so that in the living body it would take indeed a very precise and delicate adjustment to accomplish this end.

Even suppose this delicate adjustment were successful and the instrument did not enter the joint, the articular cartilage, the elasticity of which is very limited, would and does snap when forcible straightening is resorted to, and if the deformity be severe, a considerable hiatus will be left on the articular surface, just as in the original Ogston's operation. Mr. Barker* has experienced the difficulty of carrying out this operation without opening the joint, as he found that though he observed the greatest caution, the joint was yet trespassed on considerably. This has also frequently happened in the practice of other surgeons.

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* "British Medical Journal," Sept. 21, 1878.

† Dr. De Santi: "Revue Critique"—"Le Genu Valgum et les Procédés Modernes de son Traitment." "Archiv. Générales de Médecine," vol. i. June, 1879.

Regarding even the theoretical practicability of rectifying the deformity by this method without opening the joint, an American surgeon† pertinently remarks, that he is unable to understand how the mass of the internal condyle can be pushed upwards while the articular surface, with its encrusting cartilage, is preserved intact, without the removal of any of the bony substance which is heaped up at its base. There is an advantage, however, which the chisel has over the saw, even when opening the joint, that it does not leave dust or *débris* behind.

In considering the two osseous defects arising as a result of Ogston's operation—the irregular articular surface with open joint, and the sharp projection of the shifted internal condyle on the inner side of the knee—it occurred to me that they might be easily remedied by the removal of a wedge of bone in the same line. By chiselling out an accurate wedge in Ogston's line, the articular cartilage forming the apex, the separated internal condyle may then be folded up, when it becomes flush with the shaft, and no strain being put on the cartilaginous apex, it does not snap, and the joint is not opened. This operation was performed several times post-mortem, and after satisfying myself as to the facts, this procedure was carried out in a case of double knock-knee. This was performed on May 10th, 1878,‡ and it gave a satisfactory result, but not such a perfect one as was obtained by me, by my first operation—division of the diaphysis of the femur at its condyloid extremity. Besides, the removal of a wedge is much more difficult to execute than a simple incision. I have no doubt, also, that in practice the joint would sometimes be opened. For those who still prefer the separation of the internal condyle, this operation would be preferable, in the adult, to the loosening or separation of that structure by saw or chisel. With the exception of avoiding the two osseous defects, it is liable to all the other objections which are urged against the separation of the internal condyle. This operation was only once performed by me; it was found much more difficult than the simple osteotomy across the shaft, and did not, on the whole, give such a good result, so that I have never repeated it and cannot recommend it, very much preferring my original operation.

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* Mr. Barker: Op. cit.

† "Remarks on the Operative Treatment of Genu Valgum," by Geo. R. Fowler, M.D., and Lewis S. Pilcher, M.D. New York, 1879.

‡ Seven days before Reeve's modification of Ogston.

Another operation, having the displacement of the internal condyle for its object, was performed by Mr. Chiene, of Edinburgh, in April, 1877.*

Instead of sawing or chopping off the internal condyle, Mr. Chiene removes an obliquely transverse wedge of bone from the base of the condyle, and then bends the narrow neck of bone still attaching the structure to the shaft, and so displaces the condyle upwards. Mr. Chiene thus describes his operation:—"Find the tubercle on the internal condyle to which the long tendon of the adductor magnus is attached; an incision two to three inches in length is made over the tubercle in the long axis of the limb. The incision commences half an inch below the tubercle, and is carried upwards for a sufficient distance. After the division of the skin and the fascia, the tendon of the adductor magnus is exposed. Pass in front of the tendon, between it and the fibres of the vastus internus. The bone, covered by periosteum, is exposed, and the superior articular artery is seen and divided, after passing a double ligature below it and tying the vessel. The periosteum is then crucially incised and turned aside, exposing the bone. With the chisel and mallet a wedge-shaped portion of bone is removed from the base of the condyle immediately above the tubercle of attachment of the adductor magnus. The breadth of the wedge will depend on the amount of the deformity. The long axis of the wedge runs downwards and outwards toward the notch between the condyles. The wedge is at a higher level than the epiphyseal line. The apex of the wedge may touch the line."

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* Mr. John Chiene: "On the Treatment of Knock-knee"—"Edinburgh Medical Journal," 1879, p. 881.

All the operations which sought to separate the internal condyle were performed in Ogston's line. Mr. Chiene, however, introduced the novelty of separating the internal condyle by an incision in a slightly different direction.

Mr. Chiene states that the wedge is removed at a higher level than the epiphyseal line; this is, however, at variance with the description of the operation. He states that the wedge is commenced immediately above the tubercle for the insertion of the adductor magnus tendon. This tubercle represents the internal position of the epiphyseal line. Most often the tubercle is below the epiphysis, though sometimes the epiphysis runs through it. If, then, the wedge is begun immediately above this tubercle, it, at the very outset, is liable to encroach upon the epiphysis, but as the long axis of the wedge runs *downwards* and outwards toward the notch between the condyles, it is evident that a considerable portion of the epiphysis is removed. Though theoretically the operation may be performed without opening the joint, still in practice the joint is almost certain to be opened either during the operation or on straightening the limb.* Dr. Pilcher, in reviewing this operation, says:—"Fracture of the connecting bridge of bone is probable, which, indeed, Mr. Chiene informed me had occurred in some of his cases. The second case operated on by Mr. Chiene, which I have related, illustrates the unsatisfactory results of the operation in aggravated cases, involving a severe operation, tedious repair, and long continued weakness of the limb." The length of the incision required, the somewhat careful dissection necessary, the ligation of an artery, the elevation of a portion of periosteum before beginning to remove the wedge, are disadvantages which, when associated with the other drawbacks, are sufficient to have caused this formidable operation to have been seldom practised.

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* Geo. R. Fowler, M.D., and Lewis S. Pilcher, M.D.: Op. cit.

THE DEFECTS IN SEPARATING THE INTERNAL CONDYLE IN GENU VALGUM.

As all the foregoing operations have the same end in view—the loosening of the internal condyle and the placing of it on a higher level—they are all liable to certain defects, some to a greater extent than others.

Several of these operations have been devised under the erroneous belief that the sole cause of the deformity in genu valgum lay in an elongated condyle. Even suppose it were granted that this was the true pathology, it does not exclude the physical condition being remedied by operating through the diaphysis. Now, however, more correct ideas of genu valgum prevail, indicating that, though in most cases the internal condyle is elongated, yet it is only one of the factors, often the least important, the lower third of the femur being most often bent inwards. So that the pathological conditions do not indicate a predilection for this procedure; on the contrary, if the pathology points to a part which ought to be selected, that part is the condyloid femoral diaphysis. If its pathological *raison d'être* is obscure, its anatomical basis is more so.

It produces an irregular articular surface, a sharp projection of bone on the inner side of the knee, caused by the sawn or chiselled surfaces being pushed upwards, and it leaves untouched the strong ligaments and tendons on the outside of the joint, while it at the same time removes any resisting influence which the structures on the inner side of the knee might have in maintaining the compactness of the joint, by dividing above the attachment of the internal lateral ligament. On the other hand, the external lateral ligament might be ruptured, in severe cases, where forcible straightening is resorted to, and a loose joint ensue. These defects are pronounced according to the severity of the case.

Then, surgically, the joint is opened, its integrity is encroached on, either by the instrument or while straightening the limb, and effusions of blood and synovial fluid are apt to ensue. When the saw is employed, bone *débris* and dust are deposited in the joint. These defects are most marked when the saw is used, much less when the chisel is employed for simple division; and least when wedges are removed. But the removal of a wedge requires such care, and is withal such a formidable operation in this region, that its good qualities are counterbalanced.

Some of these defects are illustrated by the post-mortem of a patient, sixteen years of age, who died from acute uræmia, six weeks after Ogston's operation had been performed by C. Thiersch, of Leipsic.* He says:—"There was a rugged fracture into the joint; the angle resulting from the breakage was filled up by osseous material, mainly derived from the periosteum. The sawn surfaces of the condyle and the shaft were separated by three or four millimetres, the gap being filled by a delicate red tissue, formed by the organization of blood-clot. On the cartilage and synovial membrane the remains of blood-coagula were also visible." Fig. 20 is the drawing, after Mikulicz, of the interior of the knee-joint. One sees here the opening into the joint, the gap left between the condyles, and the irregular articular surface. Fig. 21 is a longitudinal section through the condyles from the same patient, exhibiting a wedge-shaped hiatus between the internal condyle and the femoral shaft and the sharp projection of the upper and inner part of the internal condyle. This hiatus is in process of repair.

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* "Centralb. f. Chirurg." No. 6, 1879; also see in Langenbeck's "Archiv für Klin. Chir." Bd. xxii. H. 2. April, 1879.

It may be stated that these objections have not proved formidable in practice, and many believe that, practically, they may be ignored. It is argued that, though the joint

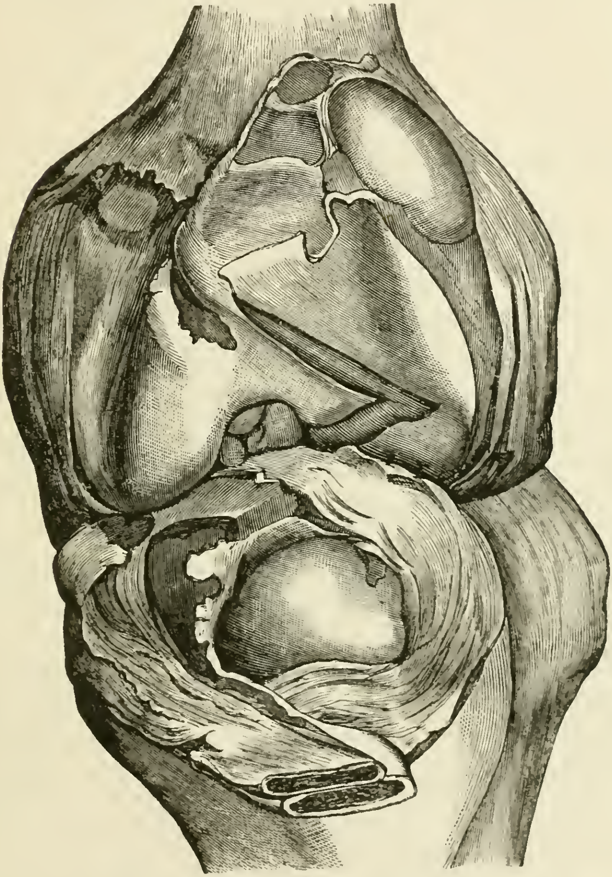

FIG. 20.—KNEE-JOINT AFTER OGSTON'S OPERATION, AS PERFORMED BY THIERSCH.

is opened, filled with blood and bone *débris* deposited in its interior, these become absorbed; that the irregular articular surface fills up through time; that the sharp projecting portion of bone on the inner side is also, by and by, rounded off, &c. There can be no doubt that the deformity can be successfully obliterated by this operation, and the success attending it has been very great; but the immunity from ill effects has in a considerable degree been due to the bounty of Nature, who does her utmost to remedy the defects spoken of. It is preferable not to court these gratuitously—all the more so, as they are completely avoided by another easier and less formidable method.

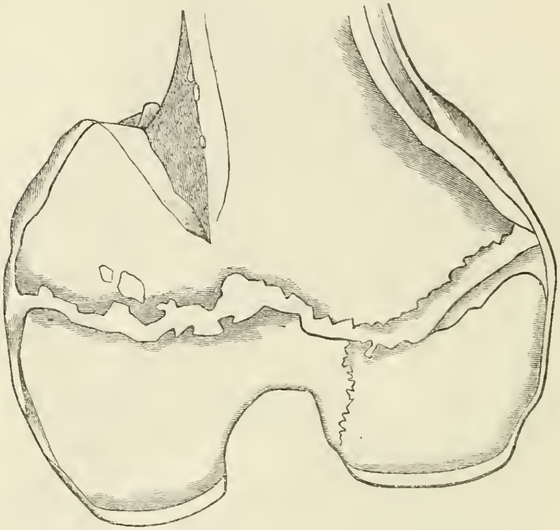

Fig. 21.—Longitudinal Section after Ogston's Operation, showing Hiatus between Condyle and Shaft. (Thiersch.)

CHAPTER XIV.

GENU VALGUM—OSTEOTOMY BELOW THE KNEE, AND MULTIPLE OSTEOTOMIES.

OSTEOTOMY BELOW THE KNEE FOR GENU VALGUM—DOUBLE OSTEOTOMY FOR GENU VALGUM: DIVISION OF THE TIBIA AND FEMUR—TRIPLE OSTEOTOMY FOR GENU VALGUM: DIVISION OF FEMUR, TIBIA, AND FIBULA.

OSTEOTOMY BELOW THE KNEE FOR GENU VALGUM.

Probably the earliest operation for the rectification of the osseous deformity in knock-knee was performed by Mayer, of the Orthopædic Hospital, at Würzburg, on August 14th, 1851.[*] Dr. Mayer made an incision, beginning three-quarters of an inch below the insertion of the ligamentum patellæ and curving downwards, so as nearly to surround the front and inner (or mesial) side of the head of the tibia. He then turned the flap upwards, and divided the periosteum in the line of the first incision, and afterwards, with Heine's cutting needle, separated the periosteum from the outer and posterior surfaces of the tibia, so as to prepare for the use of the saw. With a round saw two incisions were made, converging towards the posterior part of the tibia, and meeting about a line and a half from the surface, without, therefore, quite cutting the bone in two. The wedge was excised, and the cut surfaces of the bone brought into close apposition, without cutting the fibula. The opposite limb was operated on on October 3rd of same year. The boy, who was fifteen years of age, strong and healthy, recovered perfectly, the wounds healing by first intention, and he left the hospital on November 19th, walking with a firm and natural gait.

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[*] "The Lancet," 1853, p. 557.

An account of Mayer's operations may be found in Gunther's "Operations on the Lower Extremities."*

Mikulicz, in commenting on Mayer's operations, states that one of his patients died, and though two others were more successful, still the severity of the operation prevented its adoption.

The tibia and fibula have been operated on by two Continental surgeons, for the relief of genu valgum. Billroth† performed a simple section of the tibia, in a case of genu valgum, on July 2nd, 1873, a somewhat similar operation having been performed by him for genu varum on December 16th, 1872. Dr. Schede,‡ of Berlin, cut a wedge out of the tibia, and then divided the fibula, in a case of knock-knee, on February 23rd, 1876. In the first instance he used a saw, in the second case he operated with the chisel. These two cases were shown by him before the Sixth Congress of German Surgeons.

This method of operating must be very seldom required, as the tibia is not so much involved in the majority of cases of genu valgum as to require special attention; and in those cases in which it may be supposed to require division the condyloid diaphysis of the femur is, as a rule, much more at fault than the tibia, consequently the femur demands attention in the first instance.

On one occasion, however, a deformity came under my notice, which, though simulating knock-knee, was not in reality such, the limbs being well formed and straight down to three inches below the articular surface of the tibia. From this point the tibia was formed at an acute angle outwards, so that the patient walked much in the same way as knock-kneed patients generally do. The commencement of the angular deformity was marked by a prominent tibial spine on the inner side. This was a peculiar case, and ought to be correctly included under tibial deformity. In this instance the deformity was traceable to uterine life. Dr. Schede's operation was performed here, the wedge being struck out of the part of the tibia corresponding to the abnormal spine. The result was good, the wounds being healed in a fortnight, and the limbs being straight.

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* Kindly sent me by Dr. Chevasse, Birmingham.

† Langenbeck's "Archiv," 1875.

‡ "Berlin. Klinische Wochenschrift," 1876, No. 52; also "London Medical Record," June 15, 1877, p. 246.

DOUBLE OSTEOTOMY FOR GENU VALGUM: DIVISION OF THE TIBIA AND FEMUR.

In the majority of instances of genu valgum, the tibia is not involved to an extent demanding the practical consideration of the surgeon. Even in genu valgum adolescentium, the tibia is not invariably involved, and in most instances, even when involved, it is to such a slight extent that the femoral incision is alone sufficient to enable the limb to be brought into a straight line, without producing one deviation for another, as has been remarked. Not only so, but even in those cases where the tibia is involved to a marked extent in the production of knock-knee, the limb may be brought, by the femoral incision alone, *sufficiently* straight to enable the weight of the body to fall on a line drawn through the knee and the middle of the ankle-joint —thus making a limb which, as far as utility is concerned, is as good as when the tibia is cut as well as the femur. When such a limb is exposed, the flattening of the tibial head and the spines which project on the internal surface, appear prominent and make a lower limb, which when nude is not symmetrical, but when clothed appears quite straight. In one of the most aggravated cases of genu valgum which has come under my notice, occurring in a man twenty-one years of age, the limb was brought into a straight line by femoral osteotomy, the tibia not being touched. The tibia, having the flattened head and well-marked buttresses on the inner side, is still to that extent deformed, though the genu valgum is obliterated. But even the addition of a simple tibial osteotomy would not do away with this portion of the deformity; it might assist, though it would not efface it. There is another fact to be remembered, that one accustomed to the great amount of straightening brought about by the femoral incision is much disappointed by the small comparative result brought about by division of the tibia at the foot of the anterior tuberosity. The same thing happens equally when the fibula is divided in conjunction with the tibia. It is probable that the great mass of muscle on the outside and back of the limb tends to bind the tibia and make it more inflexible. Even the removal of a wedge from the inner side of the tibia does not afford the same amount of straightening as one would expect who has seen the femur divided and the rectification resulting therefrom.

Keeping these reservations in mind, the tibial incision, in cases of *very* aggravated genu valgum, is not only justifiable, but conduces to the ultimate result, imparting greater symmetry to the limb. In operating on the tibia, the form of the section of the bone just below the anterior tuberosity ought to be kept in view, though to the outline of the normal section, a considerable flattening and lateral elongation of the bone toward the inner side, ought to be added. In dividing the tibia, after having first operated on the femoral expanded diaphysis, one finds, as a rule, a very great contrast in the density of the bones, the tibia being much the harder and being more difficult to cut. This density is greater the lower the incision is made. If it be made through the head of the tibia, spongy cancellated tissue is met with, which would enable the instrument to pass easily through. But it is too near the joint, and might interfere with important structures.

The manner of performing the operation is as follows:—An incision in the soft parts, sufficient to admit the osteotome, is made at a point on the inner side of the tibial surface, midway between the anterior and posterior border, and opposite the lower border of the tibial tuberosity. The tibia is then divided from within outwards, commencing from the posterior border, and raising the osteotome gradually up until it comes into contact with the anterior surface at the lower portion of the tubercle, which is by far the most dense portion. The osteotome ought then to be directed from before backward, the tissues to the outside being gently retracted meanwhile, and so this dense part is divided. The femoral and tibial incisions ought to be performed at the same sitting.

I have never seen the necessity of touching the fibula, either by causing a simple fracture or by cutting, in any case of genu valgum.

In one very marked case of genu valgum, where the deformity was equal in both limbs, the tibia was divided in one limb along the femoral incision, and in the other the femoral osteotomy was alone performed along with division of the biceps tendon, and the result of the latter operation was the better of the two, though both were good. Though this double osteotomy was introduced by me in April, 1878, and many times performed during that year, still, of late, it has been, with very few exceptions, abandoned by me, trusting to the femoral incision alone, or combined with tenotomy of the biceps.

TRIPLE OSTEOTOMY FOR GENU VALGUM: DIVISION OF FEMUR, TIBIA, AND FIBULA.

In 1878 Mr. Barwell performed a triple osteotomy for genu valgum. His method consists of a double procedure, with a considerable interval of time between each. First he divides the femur with a chisel, a little above the epiphyseal junction, for about its external two-thirds. He then straightens the limb, and allows the gap thus left at the end of the femur to fill up and consolidate. When this has taken place, he completes the second step of the operation, by oblique division of the fibula and transverse division of the tibia, about an inch below the joint, and then brings the limb into a straight line.

Mr. Barwell performed the first part of this operation on February 14th, 1878,* and the second part on March 7th, 1878. Mr. Barwell believes that the pathological anatomy of genu valgum bears him out in his adoption of the triple method. While admitting that the tibia is involved, in certain cases of genu valgum, it is yet involved, in the great majority of these, to such a slight extent that the whole of the deformity may be perfectly rectified by the femoral incision alone. Though the performance of triple osteotomy seemed unnecessary, yet it was determined, in one case, to test its value experimentally. A patient, sixteen years of age, affected with double genu valgum, both limbs being equally deformed, and that to an aggravated extent, had triple osteotomy performed on one limb, while its fellow was submitted to the usual femoral incision, along with division of the biceps tendon. The one limb was found to be quite as straight as the other, the triple osteotomy in this instance being of no service, everything necessary for the straightening having been gained by the femoral incision, along with the division of the biceps, and there were no subsequent benefits experienced.

Regarding triple osteotomy, Mr. Barker† thus speaks:—"No very great advantage has been generally recognized for this operation. Its disadvantages are apparent: a double osteotomy where one will suffice, and so increased danger and loss of time; a gap left at the lower end of the femur to be filled up by material which will afterwards yield before quite solid to the weight of the body; and this instead of a lesion (Macewen's operation), resembling more an impacted fracture than anything else." In a subsequent correspondence‡ between Mr. Barker and Mr. Barwell, the former says, "I felt justified in concluding that I did in some measure express the general opinion in regard to the relative value of the operation, from having observed in rather an extensive reading on the subject (and Mr. Barwell will correct me if I am in error), that though his method has been brought prominently forward, and its claims advocated, not only in his first interesting paper, but in a subsequent correspondence, nevertheless, for every case recorded of operation by this method, I believe I have met with a score treated by Ogston, Macewen, or Reeves—perhaps I should say scores." Mr. Barwell, in a subsequent paper, admits this, but hopes, when an enlightened view of the pathology is taken by the profession, that the triple osteotomy will be more often performed.

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* "British Medical Journal," May 25, 1878.

† Barker: "British Medical Journal, July 5, 1879, and Aug. 2, 1879.

‡ Barwell: "British Medical Journal," Oct. 18, 1879.

CHAPTER XV.

GENU VALGUM—SUPRA-CONDYLOID OSTEOTOMY: OSTEOTOMY THROUGH THE EXPANDED CONDYLOID FEMORAL DIAPHYSIS.

HISTORY OF THE OPERATION—REMARKS ON THE ANATOMY OF THE PARTS CONCERNED—LIGAMENTS OF KNEE-JOINT—CONDYLOID EPIPHYSIS—TRANSVERSE SECTION OF A LIMB AT SEAT OF OPERATION—ADVANTAGES OF OPERATING AT THIS PART—THE EXACT SEAT OF THE INCISION IN THE SOFT PARTS—DIRECTION OF THE OSSEOUS INCISION—TRANSVERSE EXTENT OF THE OSSEOUS INCISION.

HISTORY OF THE OPERATION.

THIS operation was first performed by me on May 19th, 1877, by making a transverse cuniform incision through the expanded portion of the femoral diaphysis, dividing the bone from within outwards. Instead of the cuniform operation, a simple incision was substituted by me on February 2nd, 1878; in other respects it was the same operation, having the same objects in view, and effecting the same results, but in an easier and better way. Both these operations were simultaneously published by me in the "Lancet," March 30th, 1878.*

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* It has been erroneously stated that this operation is similar to one performed by Mr. Chiene. The two are in no way similar, as the reader can judge, by comparing the description of that gentleman's operation with that about to be given. His operation is one for separation of the internal condyle by removing a wedge therefrom; this operation is a simple transverse incision of the condyloid diaphysis of the femur, altogether avoiding the internal condyle, and preserving it *intact*.

REMARKS ON THE ANATOMY OF THE PARTS CONCERNED IN THIS SUPRA-CONDYLOID OPERATION.

Some current erroneous impressions may be removed by presenting the accompanying schematized woodcut, and by recalling one or two points connected with the seat of the operation. The woodcut represents the lower part of the femur, the front, inner, and back aspects being brought into view. The dotted line shows the position of the epiphysis. A few fibres of the adductor magnus muscle and its tendinous insertion into the spine on the inner condyle are figured. One or two faint lines running obliquely over the inner aspect indicate the direction of the fibres of the vastus internus. The shaded, somewhat triangular portion, above the patellar articular surface, represents the position covered by the upward prolongation of the synovial pouch in front. On the inner side of the femur is a cross, the heavy line of which, running longitudinally to the femoral axis, represents the seat of the incision in the soft parts, while the light transverse line shows the position of the osteotomy. The somewhat circular drawing placed under the femur is an outline of a transverse section of the femur at the seat of operation, the portion next the condyle being the inner side.

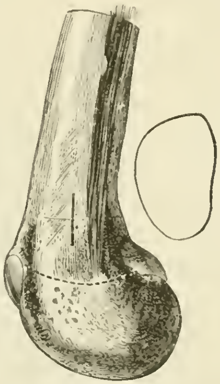

Fig. 22.—Distal Extremity of Femur, showing position of Supra condyloid Operation.

A fact often overlooked is the marked difference between the antero-posterior diameters of the outer and inner borders of the femur at this part. For a short distance above the condyles, the femur has a much thicker outer than inner border; in many instances the outer is twice as thick as the inner. If the form of the bone be not borne in mind, the surgeon may think that he has divided it sufficiently, and yet he may find that it will not yield, owing, in most cases, to the posterior outer part remaining intact. The line of osseous incision is considerably above the epiphysis, and, consequently, cannot do it harm. The epiphysis may be surgically represented by a line drawn across the femur at the level of the highest point of the femoral articulating surfaces, and it runs through or just below the spine on the inner condyle for the insertion of the adductor magnus tendon; so that in making the incision an inch to an inch and a half above the spine, the epiphysis will be cleared. The only portion of the synovial pouch which is as high as the osseous incision is the narrow prolongation under the quadriceps extensor tendon. This prolongation may reach, in the adult, about a couple of inches above the front part of the femoral articulating surface. It is somewhat triangular in shape, its base being at the condyles, and it gradually tapers toward the middle line as it ascends. It is attached to the under surface of the ligament and moves with it, so that in flexing the knee it is carried well down. There is a quantity of adipose tissue separating the pouch from the bone. The point selected by me for the incision in the soft parts is on the inner side of the limb, posterior to the pouch. The manner of introducing the osteotome, first longitudinally, until it reaches the bone, then turning it transversely, would push the pouch aside, even if it were, in any case, so much distended as to reach so far as the inner side, and the osteotomy would be performed behind it. Regarding the arteries, the femoral passes through the aperture in the adductor magnus much above the seat of the operation, and, with ordinary care, cannot be injured in its position behind the femur, as there is a considerable quantity of adipose tissue between the artery and the bone. The osteotome, in cutting the posterior inner part of the bone, ought to be directed from behind forward, so as to cut away from the artery. The anastomotica magna runs close to and parallel with the adductor magnus; the superior internal articular runs off below the line of my incision, so that neither are injured.

LIGAMENTS OF KNEE-JOINT.

It has been pointed out in the observations on the foregoing operations, first, that those which separate the internal condyle interfere with the integrity of the joint, and that the ligamentous structures on the outer side, which help to retain the limb in its deformed position, are left untouched; second, that those which either purposely sever the external lateral ligament by tenotomy, or those which

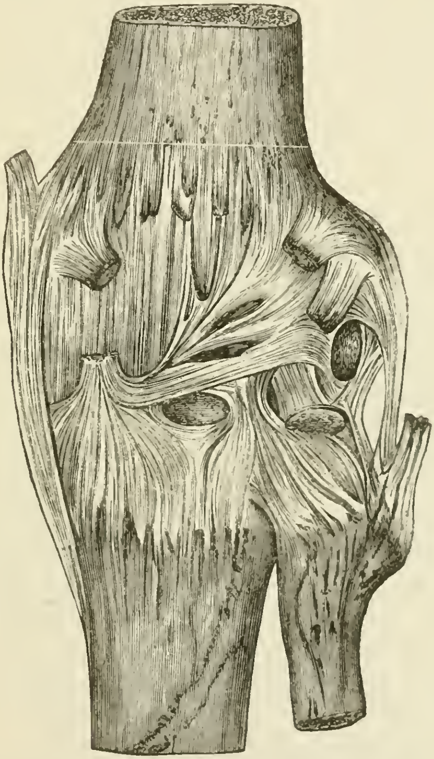

FIG. 23.—POSITION OF SUPRA-CONDYLOID OPERATION IN RELATION TO THE LIGAMENTS OF THE KNEE-JOINT.

rupture that structure in executing such a procedure as *redressement forcé* in the adolescent, leave a loose joint, which in itself constitutes a serious and awkward lesion. In the first the strong ligament is left as a factor, tending to maintain the deformity; in the second it is cut or ruptured, and a loose joint ensues. Both these defects are obviated by the incision through the condyloid portion of the diaphysis. The incision is above the attachment of the external lateral ligaments and the popliteus tendon, and they are moved along with the external condyle, and in no way interfere, but rather help in rectifying the deformity. Reference to the accompanying woodcut, adapted from Morris' "Anatomy of Joints," shows that this operation is clear of all the structures immediately concerned in maintaining the joint-surfaces in close apposition, so that the joint is not only kept intact, but its ligamentous structures are also preserved in their pristine condition. The white line, Fig. 23, represents the seat of operation.

THE CONDYLOID EPIPHYSIS.

The epiphysis is indicated on the inner side of the limb by the spine for the insertion of the adductor magnus tendon, and on the anterior surface by the external border of the femoral patellar articular surface. These two points are always readily felt in the living body through the skin. Besides, in the person affected with genu valgum, the external condyle has its upper border on a higher level than the spine for the insertion of the adductor magnus tendon, so that a transverse line running a finger-breadth above the upper border of the

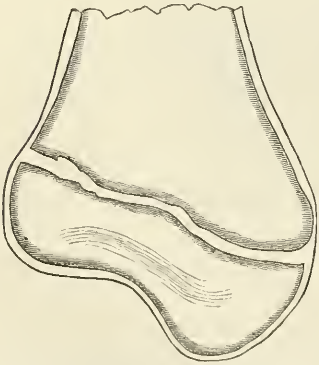

Fig. 24.—Section of Femur affected with Genu Valgum.

external condyle may be taken as a point clear of the epiphysis. This can be readily seen from the accompanying transverse section of the femur affected with genu valgum (Fig. 24).

TRANSVERSE SECTION OF THE LIMB AT SEAT OF OPERATION.

The accompanying figure is a transverse section of the limb at the seat of operation, showing the bone in relation to the soft structures. It was taken from a frozen section, prepared from a robust adult male, by Dr. Clark, Lecturer on Anatomy in the Glasgow Royal Infirmary. The configuration of the bone, the distance which exists between

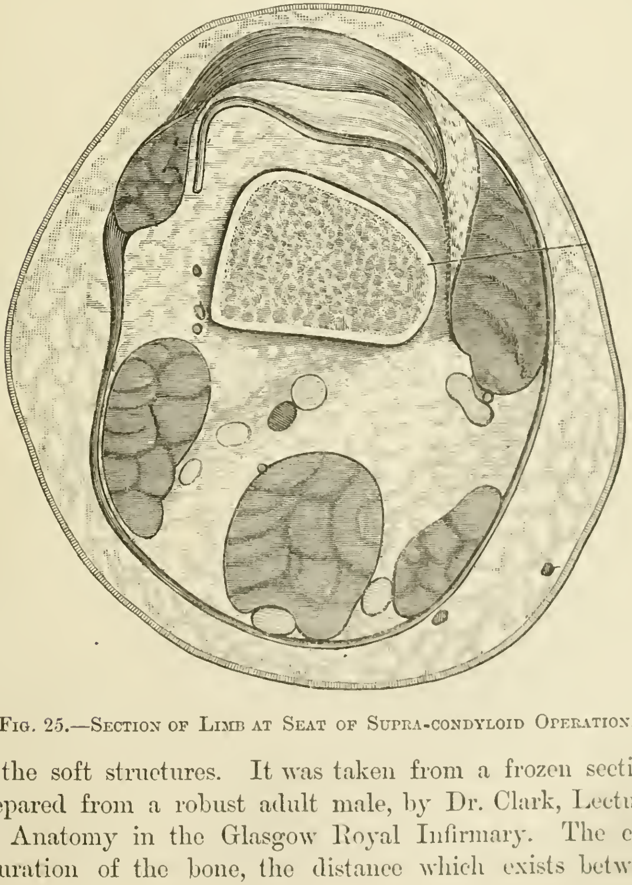

Fig. 25.—Section of Limb at Seat of Supra-condyloid Operation.

it and the upward prolongation of the synovial pouch on the one hand, and between it and the great vessels on the other, may be easily judged of. The straight line indicates the soft tissues penetrated. The amount of adipose tissue is greater than what is usually met with.

ADVANTAGES IN OPERATING AT THIS PART.

Thus, simple osteotomy through the expanded portion of the femoral condyloid diaphysis in no way affects the articulation of the knee; it preserves the joint with its ligaments firm and compact, it is clear of the epiphysis, and cuts no vessel requiring ligature. The longitudinal incision in the soft parts passes through skin, cellular tissue, and a few fibres of the vastus internus, and by dividing these at one stroke a wound is made which, treated antiseptically, heals without the production of a single drop of pus. It also answers all the requirements indicated by the pathological anatomy of genu valgum; the osseous incision being made through the inner side of the distal portion of the femoral diaphysis, the part which is most affected in genu valgum.

THE EXACT SEAT OF THE INCISION IN THE SOFT PARTS.

The incision in the soft parts is made on the inner side of the limb, at a point where the two following lines bisect one another: a line drawn a finger-breadth above the level of the upper border of the external condyle, and a line drawn parallel to, and half an inch in front of, the tendon of the adductor magnus. This position is below and anterior to the anastomotica magna, and above the superior internal articular, and by making an incision from half an inch to an inch in length directly to the bone at this point, it is impossible to touch any normal distribution of these branches. Any bleeding which may occur from superficial veins can be completely arrested by pressure with a sponge for a few minutes.

Some surgeons have told me that in performing this operation they have had arterial bleeding, necessitating the application of a ligature. In such cases one would be inclined to think that their incisions had not been made in the position indicated. In double genu valgum, after operating on one limb, a carbolized sponge is placed over the wound, and retained in its position by a gauze bandage. The elastic webbing is then removed, and gentle pressure is exercised over the wound during the time the neighbouring limb is being operated on. The wound in the second limb is similarly treated while the first is being dressed. In this way, the venous bleeding is arrested before the dressing is commenced. In the last 150 consecutive cases no ligature has been applied, and it is a rare occurrence to find the dressings stained with blood to such an extent as to require renewal. The blood-stain is generally confined to the innermost fold of a gauze placed over the wound, sometimes even confined to the small piece of protective plaster covering the wound.

Besides the skin and cellular tissue, the instrument passes through a few fibres of the vastus internus at its thinnest part.

DIRECTION OF THE OSSEOUS INCISION—AVOID ENCROACHING ON THE EXTERNAL CONDYLE.

The surgeon ought to remember that the normal relation of the external to the internal condyle is altered in genu valgum. In the normal limb, a line drawn from the spine for the insertion of the adductor magnus tendon transversely to the axis of the limb, would in most cases pass into the upper part of the external condyle; but in genu valgum the whole internal condyle is lowered, so that a line drawn at right angles to the limb's axis, at the level of the spine, would pass into the middle of the external condyle, and would also encroach on the anterior femoral articular surface. In fact, in some very aggravated cases of genu valgum, a line drawn from the spine for the insertion of the adductor magnus tendon transversely to the body, would land very near the lower portion of the external condyle. The safest guide for the transverse osseous incision is that already given for the incision in the soft parts—a line drawn transversely a finger-breadth above the upper part of the external condyle—the osseous incision beginning on the inner side of the limb. One might also effect the osseous incision, by commencing half an inch to an inch above the spine for the insertion of the adductor magnus tendon, and then cutting parallel to the condyles. Of the two the former line is preferable.

Some surgeons have expressed a difficulty experienced by them in endeavouring to carry out this operation of division of the femoral diaphysis; first of all while dividing the bone, and secondly while bending or snapping the outer layer, after they considered it sufficiently divided. Not only so, but as a result, in some cases, a projection, which could be felt under the skin, and sometimes seen, appeared on the anterior internal aspect of the limb. It is more than probable that, in these cases a mistake has been made in beginning the incision too low and then cutting transversely to the axis of the trunk, and so landing the instrument in the massive external condyle, where the operator, especially if it be his first case and that occurring in the adult, is apt, while cutting, to lose his bearings, and find the bone difficult to bend or snap. Besides the disadvantages which the surgeon experiences, the upper external anterior extremity is apt to project, and to appear unseemly. Besides, the transverse division of the external condyle may interfere with the origin of the plantaris, the outer head of the gastrocnemius, and even the popliteus muscles. A little consideration of the relation of the condyles, as given above, will be sufficient to enable this error to be avoided.

THE TRANSVERSE EXTENT OF THE OSSEOUS INCISION.

The extent of the osseous incision depends on the nature of the case. When the bones are soft and yielding, as is generally the case up to fifteen or sixteen years of age, and typically so in plump girls of that age, the bone ought to be divided for over the internal two-thirds; the remainder may then be easily bent so as to form a green-stick fracture. In this case the bending ought to be performed gradually, and not with a quick jerk. On the other hand, when the bones are hard and brittle, when the feeling imparted to the osteotome is similar to that conveyed in cutting dense bone, and when even by a smart mallet impact little impression be made—these are cases in which the incision ought to pass to the dense shell of bone on the outer side, leaving it alone to be snapped. This state of bone is sometimes met with in the adult, twenty years and upwards (though sometimes much younger); especially in those who have been ricketty, the bones are found at that age to contain a large proportion of earthy matter, and are brittle. The individuals are thin, and have a scraggy, peculiar look, which in a short time the surgeon begins to recognize. In these cases everything ought to be done by cutting with the osteotome, and as little as possible left to be snapped. It is also especially necessary to avoid much force in snapping. It has been stated that some operators place their knee as a fulcrum on the joint, and so break the bone. The employment of such force is not only quite unnecessary, but, in the class of cases at present under notice, might lead to serious comminution; and even to what is worse, a separation of the ligaments on the outside of the joint. When the surgeon—placing his left hand over the wound, takes the right lower limb in his right hand, then using the left as a fulcrum and the right as a lever—finds that he cannot readily cause the bone to yield, he may be sure that he has not sufficiently cut the bone all round; he ought to desist from attempting to snap the bone, re-introduce the osteotome, and find the point that requires division. Most often (when the surgeon has avoided the external condyle) the posterior border has some little point requiring division, when a very few touches with the fine osteotome will remove the obstacle to easy bending or snapping. After a little experience the re-introduction of the instrument is seldom required.

CHAPTER XVI.

GENU VALGUM—MODE OF PERFORMING SUPRA-CONDYLOID OSTEOTOMY AND AFTER-TREATMENT.

MODE OF PERFORMING THE OPERATION—ADVANTAGES OF THIS MODE OF OPERATING—DIVISION OF THE BICEPS TENDON—DRESSING OF THE WOUND—AFTER-TREATMENT—ILLUSTRATIVE CASES.

MODE OF PERFORMING THE OPERATION.

THE patient having been anæsthetized, the limb is rendered bloodless by Lister's or Esmarch's method; it is then laid on a sand pillow, which is moulded to the limb, so as to afford a firm, unyielding support. One assistant places a hand on the upper part of the tibia, while another fixes the upper part of the thigh. The operator sponges the seat of the operation with one-to-twenty watery carbolized solution; the spray is then directed on the part. A sharp-pointed scalpel is introduced at a point where the two following lines meet—one drawn transversely a finger-breadth above the superior tip of the external condyle, and a longitudinal one drawn half an inch in front of the adductor magnus tendon. The scalpel here penetrates at once to the bone, and a longitudinal incision is made sufficient to admit the largest osteotome and the finger, if the operator desires it. Before withdrawing the scalpel, the largest osteotome is slipped by its side until it reaches the bone. The scalpel is withdrawn, and the osteotome,[1] which was introduced longitudinally, is now turned transversely in the direction required for the osseous incision. In turning the osteotome, too much pressure must not be exerted, lest the periosteum be scraped off. It is then convenient to pass the edge of the osteotome over the bone until it reaches the posterior internal border, when the entire cutting edge of the osteotome is applied, and the instrument is made to penetrate from behind forward and toward the outer side. After completing the incision in that direction, the osteotome is made to traverse the inner side of the bone, cutting it as it proceeds until it has divided the uppermost part of the internal border, when it is directed from before backward, toward the outer posterior angle of the femur. On cutting on these lines there is no fear of injuring the femoral. The bone may be divided without paying heed to this order, but it is better that the operator should have a definite order of procedure in his mind, so that he may be certain as to what has been divided, and what remains to be done. In children the mere introduction of the instrument from the inner toward the outer side is often quite sufficient. In using the osteotome, the left hand, in which it is grasped, ought to give, after each impulse supplied by the mallet, a slight movement of the blade—not transversely to its axis, but longitudinally—so as to preclude any disposition to fixity which it might otherwise assume. Soon this movement, when carried out methodically, becomes automatic. After the inner portion of the bone is divided, a finer instrument may be slipped over the first, which is then withdrawn; and a third, if necessary, may take the place of the second when the outer portion of the bone comes to be divided.

It is true that in many cases, especially in children, one instrument may suffice; but the use of two or three graduated instruments, especially in adolescents and adults, effects the following purposes:—First, it makes a more definite wedge-shaped opening; second, the cutting is much more easy when a finer instrument is introduced into the wide groove left by its thick predecessor, there being no pressure on the sides of the blades; and, thirdly, the extremity of the finer osteotome becomes in the same way a much more delicate probe, indicating the part which requires division, whereas the pressure on the sides of the first instrument introduced might be sufficient to mislead the surgeon, causing him to think that the resistance he experiences arises at the extremity of the osteotome, instead of its sides, which are fixed in the bone. Much depends on the resistance met with, whether one, two, or three osteotomes be used. If the tissue is yielding, one may suffice; if hard and brittle, two or three will effect the division easier, and with less risk of breaking or cracking the bone longitudinally. In the adult, the dense circumferential layer of bone resists the entrance of the osteotome at the outset; but several strokes cause it to penetrate this superficial dense portion, when the instrument will pass easily through the cancellated substance. After a little experience the surgeon recognizes, by feeling and sound, when the osteotome meets the hard layer on the outer aspect of the bone. If it be considered desirable to notch or penetrate this outer dense part of the bone, in doing so the osteotome ought to be grasped firmly by the left hand, the inner border of the hand resting on the limb, so as to check instantly any impetus which may be considered too great. I think it better to snap or bend this layer, and not to cut it. When the instrument is to be altered in position, it ought not to be pulled out in the ordinary way, as it is then liable to be removed from the wound in the soft parts, as well as from the bone. Instead, let the left hand, with its inner border resting on the limb, grasp the instrument, while the thumb is pressed under the ridge afforded by the rounded head, and gently lever the osteotome outwards, by an extension movement of the thumb. In this way the movement may be regulated with precision. It is desirable to complete all the work intended by the osteotome before removing it from the wound.

When the operator thinks that the bone has been sufficiently divided, the osteotome is laid aside, a sponge saturated in one-to-forty carbolized watery solution is placed over the wound, the surgeon holding this in one hand, which he at the same time employs as a fulcrum, while the other hand grasps the limb lower down, using it as a lever and jerks, if the bone be hard, or bends slowly, if the bone be soft, in an inward direction, when the bone will snap or bend, as the case may be. The limb is then brought into a straight line. A sponge, saturated with one-to-forty carbolized watery solution, is placed over the wound, and kept in position by a gauze bandage. This is retained until the neighbouring limb is operated on. After the wound is thus protected the elastic webbing controlling the circulation is removed, and the limb is held by an assistant, who practises extension meanwhile. After the other limb has been operated on, it is similarly treated while the first is being dressed.

The exact size of the wound in the soft parts must depend on the surgeon's idea. At first a wound was made which was sufficient to allow me to see what was being done during the operation; then one which enabled the bone to be felt by the finger; soon after, finding that the osteotome, acting like a probe, conveyed all the information which was necessary, the wound was reduced to a size sufficient to admit the instrument with ease, and subsequently this has been found ample. Three-quarters of an inch to an inch is the usual size.

ADVANTAGES OF THIS MODE OF OPERATING.

Besides the benefits previously mentioned as accruing from the choice of the locus for this operation, the following are considered advantages in the mode of operating:—In the division of the condyloid femoral diaphysis by graduated osteotomes, no bone is removed, the osseous tissue being merely condensed at each side. What is of more importance is the fact that the cuniform hiatus formed on the inner side is only a part of the size required for the rectification of the deformity; the remaining portion is obtained from the outer side of the bone. The incision penetrates to fully two-thirds of the femoral transverse thickness, the remainder of the bone being bent or snapped. In so doing, the tissue at the apex of the wedge acts as a fulcrum, and as the bone is bent so as to fill up the cuniform hiatus, the outer layers are either well stretched, or a wedge-shaped opening is left on the outer side, so that both outer and inner sides of the bone contribute to rectify the deformity, the quota given by the outer side being determined by the amount of straightening necessary. The gap made in the inner side by using the graduated osteotomes, has the further advantage of enabling the bone to be fractured or bent more easily than could be the case if the division were made by a simple, straight chisel. The limb being straightened, the cuniform hiatus on the inner side is thereby immediately filled up, and the small opening or rarefaction of the osseous tissue on the outer side is quickly and firmly supplied, the periosteum being preserved, though stretched over the gap.

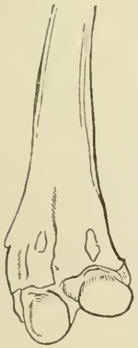

Fig. 26.—Femur affected with Genu Valgum.

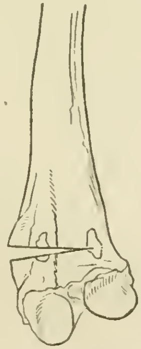

Fig. 27.—Incision made in Supra-condlyoid Osteotomy for Genu Valgum.

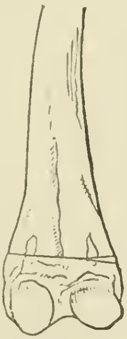

Fig. 28.—Supra-condyloid Operation for Genu Valgum—Result after Straightening the Limb.

Reference to the woodcuts will aid the reader in following the steps of the operation. Fig. 26 is a sketch of a case of genu valgum, the internal condyle being lowered, owing to the curve of the lower third of the femur and the augmentation of osseous matter on the inner distal portion of the diaphysis. Fig. 27 shows the form and direction of the osseous incision made on the inner side of the limb by the osteotomes, extending to fully two-thirds of the osseous breadth. Fig. 28 is the same limb after straightening, the cuniform gap on the inner side being now filled up by the approximation of the separate surfaces, while a slight hiatus has been left on the *outer* side of the limb, *covered by periosteum.* In many cases there is actually no gap—properly speaking—left on the outer side, the osseous tissue being stretched or rarefied, the one portion still interdigitating with the other, as is the case in a green-stick fracture. When the bone is hard and brittle the slight hiatus is left.

DIVISION OF THE BICEPS TENDON.

All the ligamentous structures about the joint after this operation assist, as the limb is straightened, in rectifying the deformity, so that they ought to be carefully preserved. The only tendinous structure which can interfere with the straightening of the limb, after the division of the femoral diaphysis, is the tendon of the biceps. The division of this structure is only required in aggravated cases of genu valgum, and ought only to be practised on finding that the limb, after the division of the femur through its condyloid diaphysis, does not become sufficiently straight. In such cases, however, it affords as much rectification as generally results from tibial division.

Care must be taken in the division of this tendon. Fortunately, in genu valgum, the tendon stands prominently out, and it may be easily divided immediately above the head of the fibula where it is very superficial. In dividing it, the tenotome is introduced between the skin and the tendon, and while the latter is placed fully on the stretch the tenotome ought to cut from the anterior and outer side, bearing in mind the position of the external popliteal nerve, which lies close to the tendon at its posterior and inner side.

DRESSING OF THE WOUND.

Before applying the dressing, it is advisable to examine the wound to ascertain whether the cellular tissue is so prominent as to protrude beyond its lips, and to come directly into contact with the covering protective plaster; if this be so, the healing will take place by granulation instead of by organization of blood-clot, the blood not having room to interpose between the protective plaster and this tissue. This is apt to occur in those who have abundant cellular tissue. When this obtains, the redundant cellular tissue is excised by a pair of scissors curved on the flat. A concavity is thus left in the wound, which is filled with blood-clot which organizes in due course.

When this has been attended to, a portion of protective plaster is placed over the wound, then a small moistened pad of gauze, six or eight fold, gently retained in position by a few turns of gauze bandage. The ordinary gauze and jaconet dressing, extending from well up the thigh to the middle third of the leg, is applied. The limb is then placed in a splint. The splint is a modification of the half box, the outer portion being carried up like a long splint to about the third or fourth rib, and it projects beyond the posterior splint at the foot. This projection is fixed in the clamp of a bed-rest, and so the whole splint and limb are kept motionless and steady. The back piece ought not to go quite to the gluteal fold; it is better to end at the junction of the upper and middle thirds of the thigh, and it ought to end a short distance above the heel, so as to leave the heel entirely free. The thigh and knee are fixed to the outside splint, while the lower leg is thrown inwards by abundant padding. It is also advantageous to place a pad of lint, extending from the trochanter major to the junction of the lower and middle thirds of the thigh. The knee in this way may be brought into a straight line, without touching the outer side of the splint.

The bandage ought not to be applied tightly at the upper part of the thigh, as at this part a tight bandage frets the patient and may be productive of mischief. In those cases of genu valgum where the internal condyle and upper part of the tibia are flattened, and end sharply on the inner side, it is best to guard these parts well by folds of lint, or they may penetrate the skin over them, even when the bandage does not seem unduly tight. The dressings and the splint ought to be applied on the operating table, while the patient is still under the anæsthetic. The patient is then placed on a mattress in bed.

The mattress consists of four parts—an upper, a lower, and two centre pieces, the latter corresponding to the gluteal region. These two centre pieces are easily moved. When the bed-pan is to be used, the gluteal region is very slightly elevated on a draw-sheet, then one of the pillows is removed, the other is slightly pushed aside, and the pan is introduced. This arrangement is found a great convenience in cases of double genu valgum or varum, where both limbs have been operated on at one time.

AFTER-TREATMENT.

When the patient recovers from the anæsthesia, the first thing to be seen to is the sensation, circulation, and movement of the toes; and the surgeon ought not to rest satisfied until he sees that the patient is able to move his toes and foot freely. Should the patient be unable to do so, the dressings must be removed and put up anew. The state of the toes must be carefully watched during the first forty-eight hours, and afterwards looked at daily. A morphia suppository may be administered if pain be experienced after the operation. Any pain felt generally disappears at the end of twenty-four hours. In the majority of cases the patient experiences no pain or inconvenience after the operation, except the restraint from the recumbent position in splints.

The temperature is recorded morning and evening. The rectal temperature will probably be found about 100° Fahr. during the first night or two. A rectal temperature of 101° Fahr. demands inquiry. Possibly it depends on some gastric disturbance. If not, there must be something wrong elsewhere, and if the cause is not apparent, the wounds must be examined. If the wounds are found right and the limb normal, the high temperature may be premonitory of some constitutional affection about to supervene. In this way the thermometer bears the same relation to bodily conditions and disturbances as the barometer to atmospheric changes. It has heralded the constitutional disturbance, ending in a tubercular attack, in a patient previously exhibiting tubercular symptoms; in another it was the forerunner of scarlet-fever; in another of diphtheria—these affections soon manifesting themselves and clearing up the difficulty. In any case of doubt, in the presence of a high temperature, it is safe to examine the wound and the limb. The pressure of a bandage may increase the temperature; when the pressure is relieved the temperature falls. When the rectal temperature remains under 101° Fahr. during the first two nights, and falls below 100° during the remainder of the first two weeks, the patient may be considered in a perfectly satisfactory condition. During the first twenty-four hours the dressings ought to be looked at, in order to detect any appearance of blood-stains. If a stain of blood shows itself externally, the dressings require removal. If there is no blood-stain during the first forty-eight hours, it is unlikely that any will afterwards appear. In the great majority of my cases there is no stain. The dressings are put on in the operating theatre; if the temperature keeps within the range indicated, if there is no stain and no pain experienced, then they are not touched till the end of a fortnight, when they are removed and the wound is found healed, the blood-clot between its lips having become organized.

Sometimes the urine requires withdrawal during the first day or two, as it does in many patients operated on for other affections, or even in many who have not learned to micturate in the recumbent position.

Though it is not advisable to touch the antiseptic dressings often, still it is important to look daily at the position of the limbs and the adjustment of the bandages, as the latter may get slack and require renewal. The readjustment of a bandage often gives ease and comfort to a patient. Guard must be made against the formation of pressure points, which are apt to ensue if the bandage is at all tight; the most frequent parts being the inner aspect of the femur and tibia, especially in those whose bones are flattened. Should the patient complain of pain and still continue to experience it after removal of the outer bandage, then the inner dressings must be removed and the nude limb examined. In the case of a patient suffering from double knock-knee, who has had both limbs operated on at one sitting, and who is attended by nurses not trained to the introduction of the bed-pan, the surgeon ought to make a close scrutiny of the limbs and their dressings every morning.

At the end of a fortnight, when the wound is found healed, the antiseptic dressings are removed, the limb is replaced in its well-padded splint for several weeks longer. When it is ascertained by individual examination that the osseous union is complete, then the splints are removed. This may take place at the end of the third or fourth, but as a rule at the end of the sixth week. After the union is firm the splints are removed, the limbs are placed on the bed and supported by sand pillows. After a few days the patient begins to exercise his limbs, while yet in bed; the surgeon may, if necessary, assist him by passive motion used gently. The patient is then allowed to rise, crutches being supplied, and care being taken that he meets with no accident until he learns how to use them. When able to walk well by their aid he is advised to go to his own home, or, if necessary, he is sent to the convalescent home for a few weeks. He is then able to walk about without artificial support, and soon becomes able for his work. As a rule, ten weeks are necessary from the time of the operation until he is able to walk freely. Some advise that the limbs be bent at the end of the sixth week, but this is not generally practised by me, the patients being able by themselves to bend their knees well by a little practice. The surgeon, however, ought to see that his patients are able to bend the knee completely before they leave the ward. If they cannot of themselves bend the knee sufficiently, they must be assisted by the surgeon. As a rule they are all ultimately able to touch the gluteal region with the heel, and to go on their knees with facility.

ILLUSTRATIVE CASES.

Fig. 29 is a woodcut taken from a photograph of a patient aged eighteen years, who was the first operated on by me for genu valgum. The one limb was operated on at first, and this figure represents the right limb straightened while the left is still affected with the deformity. Fig. 30 is a woodcut taken from a photograph of the limbs after they were both straightened. Before operation

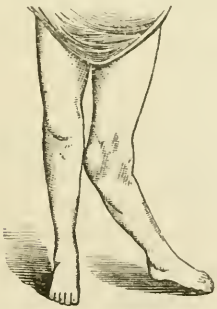

Fig. 29.—Double Genu Valgum—One Limb Straightened.

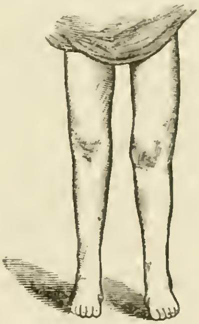

Fig. 30.—The Same—both Limbs Straightened.

the patient could neither walk nor stand for more than five minutes. Constitutionally he was very weak, and this, added to the great amount of deformity, rendered him useless. As an immediate result of the operation, his height was increased. Since then he has grown considerably, his femora increasing proportionately. He has been in active employment for the last two years as an iron moulder, and can work all day without fatigue. On one occasion he walked at a stretch fourteen miles. He has been rendered a thoroughly useful member of society, and no one would judge from his present appearance that he ever had been the subject of knock-knee or other deformity.

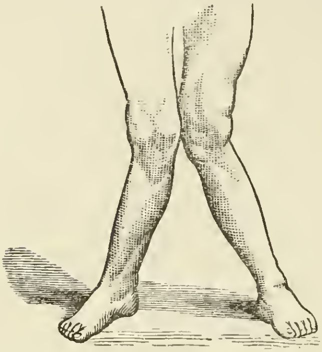

Fig. 31.—Case of Genu Valgum —Moderate Deformity.

Fig. 31 is a woodcut taken from a photograph of a moderate degree of genu valgum occurring in a lad seventeen years of age. The internal malleoli were fifteen inches apart.

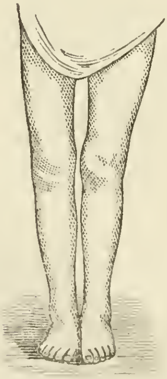

Fig. 32.—The above Case after Osteotomy.

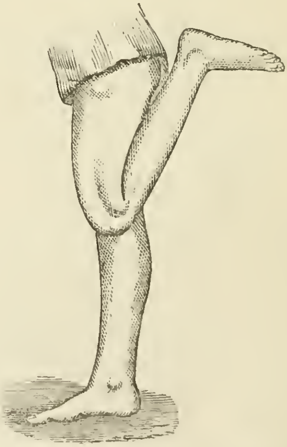

Fig. 33.—The above Case—Amount of Flexus of Knee after Osteotomy.

Supra-condyloid osteotomy was performed on both limbs at once. The wounds healed by organization of blood-clot without a drop of discharge. Six weeks afterwards he was walking about with crutches. Two months after the operation he was able to walk well without support.

Fig. 32 is a woodcut of a photograph of the limbs taken ten weeks after the operation. Fig. 33 is a woodcut from a photograph showing how the patient could bend the knee after the operation. This is considered to be a good result. This patient has since walked sixteen miles at a stretch without undue fatigue, and is employed at a standing occupation with long hours.

Fig. 34 is the result in a case of single knock-knee, the left knee being the one affected. In such cases there is often a slight affection of the neighbouring limb (most often bend outwards), but in this instance the right limb was well formed. The other limb being straight, the deformity in the left limb was all the more marked. The inequality in the length of the limbs gave rise to a considerable halt when she walked. There was a distance of nine inches between the tip of the internal malleolus and the vertical line from knee, the latter measuring ten inches. In six weeks after the operation she walked freely without support and, to her relief, without halt. She has been engaged for three years in active employment, and her limbs never trouble her.

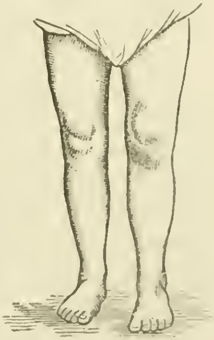

Fig. 34. — Result of Osteotomy for Single Knock-Knee.

It would be useless repetition to present more woodcuts of straightened limbs resulting from the operation. These are medium cases and average results.

CHAPTER XVII.

GENU VALGUM — MODIFICATION OF SUPRA-CONDYLOID OPERATION — DIVISION OF THE FEMUR FROM THE EXTERNAL ASPECT.

Some surgeons have adopted the supra-condyloid operation, but modified it to the extent of commencing the incision on the external instead of the internal aspect of the femur. Though no mechanist would adopt such a course to rectify this deformity, yet the surgeon, relying on Nature, believes that in her bounty she will make up for his shortcomings. I have great faith in the reparative powers of nature, yet not considering them illimitable, do not care to overtax her, or to become a mendicant on her bounty, especially when there is no occasion for it. I cannot see a single reason why the external aspect ought to be chosen in genu valgum, and it has several grave disadvantages.

First, the form of a transverse section of the femur just above the condyles may be roughly stated to be conical, the base, or broad extremity, being toward the outside; consequently the surgeon cuts towards the base from the apex, and as he cuts the anterior and posterior borders, unless he exercises great care, he is apt to allow one border of the instrument to escape and to divide the soft tissues simultaneously with the bone. The femoral artery is also in this way more liable to be cut. On the other hand, with the internal division one cuts from an apex towards an osseous base; the further the instrument enters the deeper it is embedded in the bone, and the further are its borders removed from the soft tissues. Second, in passing the osteotome, or chisel, through the femur from the outside, a wedge opening is made equal to the thickness of the instrument, the osseous tissue being compressed, and to that extent the outside of the limb is shortened instead of being lengthened. That is to say, the outside of the limb is already too short, and the operator, intending to rectify this shortening, *commences* by making it still shorter. When the operation is performed on the inner side, the side which is abnormally long is shortened. Thirdly, when the incision is made from the outside of the limb, the entire deformity is rectified from that side alone, and consequently a large gap is left to be filled by new tissue, and that, too, with the periosteum divided transversely and in no way bridging the interspace, so that the new bone must be supplied from the widely separated osseous extremities. (See Fig. 35, taken from a drawing shown in illustration of the operation by one of its advocates.) In dividing from the inside, the gap left by the graduated osteotome is immediately filled up by bringing the limb into the straight position, the cut and separated surfaces of bone and periosteum being placed in immediate contact with one another. In aggravated cases, when the deformity is very great, and the gap made by the graduated osteotome is not quite sufficient to rectify the deformity, the limb is brought into the straight position by leaving a slight gap on the outside, covered, however, by periosteum, either completely or in shreds; or if the bone be young (up to about seventeen years of age) there may be, correctly speaking, no gap on the outside, but a mere stretching of the outer layers of bone, the osseous fibres still interdigitating, somewhat after the fashion of a green-stick fracture. In aggravated cases, therefore, in cutting from the inner side both sides of the bone are made to contribute to the rectification of the deformity; the inner by being shortened,

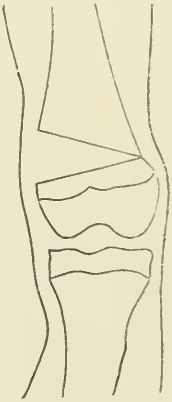

FIG. 35.—GAP LEFT IN BONE AFTER DIVISION OF FEMUR FROM OUTSIDE.

the outer by being stretched or lengthened. Fourthly, though suppuration would rarely take place, still, if it did so, it would not readily find vent, owing to the manner in which the tissues on the outside of the thigh are bound down by the fascia lata. I have been told of two cases where this occurred after cutting on the outside, and where it gave rise to very considerable trouble, counter openings behind having to be made for the exit of discharge. One would expect that those who operate from the outside of the femur, would also advise the tibial incision; the latter, so far, making up for the shortening made in the femur, and also preventing the formation of too large a gap on the outside.

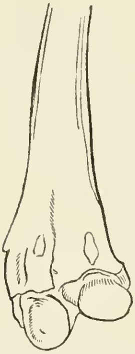

Fig. 36.—Femur Affected with Genu Valgum—Showing Deformity to be Rectified.

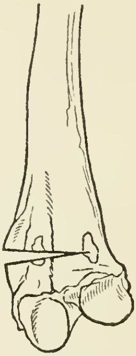

Fig. 37.—First Stage of Operation on Inner Side.

It has been said that operating on the outer side of the femur has resulted in straight, useful limbs, and that fact has been placed against my criticisms. I in no way doubt that fact as having happened in some cases, but cannot see that it is a sufficient reason for preferring that mode of operating. Straight limbs resulted in several patients who had bad knock-knees, and who came under my observation as the recipients of accident, cart-wheels having run over the deformed legs. Yet, I presume, no one would be inclined to adopt that method of straightening knock-knee, even supposing the results in those cases were good.

A glance at the woodcuts will show more clearly the relative difference between the division on the inner and that on the outer side of the femur. Fig. 36 shows the deformity to be rectified in a femur affected with genu valgum. Fig. 37 is the incision made on the inner side, of the bone; while Fig. 38 shows the same limb after it has been straightened. Fig. 39 represents the drawing of the same femur, the operation having been performed on the *outer* aspect of the femur and the limb then straightened, leaving the huge gap on the outer side, destitute of periosteum, to be filled up. If one compares Fig. 38 with Fig. 39 they will have an idea of the relative gaps to be filled up after straightening of the limbs by the different methods.

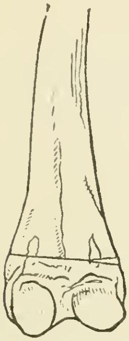

Fig. 38.—Result after Operation on Inner Side. Periosteum Preserved.

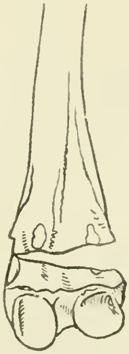

Fig. 39.—Result after Operation on Outer Side. Periosteum Cut Across.

CHAPTER XVIII.

GENU VARUM.

PATHOLOGICAL ANATOMY—OSTEOTOMIES FOR THE RELIEF OF GENU VARUM—TREATMENT—GENU VALGUM AND VARUM COMBINED—ILLUSTRATIVE CASES.

PATHOLOGICAL ANATOMY.

Genu varum presents a marked contrast to genu valgum, inasmuch as in the former the deformity is spread over a greater area, and the locus is more uncertain; it is not a fixed quantity. The limbs, as a whole, display an outward curve, the part of greatest covexity being about the knee, which is thrown beyond the centre of gravity. The point of greatest convexity is either situated below or above the knee-joint. Most frequently it is located in the uppermost part of the tibial diaphysis, commonly in the external femoral condyle. There is a very frequent external curve in the lower third of the tibia and fibula, which in many cases would be more correctly expressed as an inner curve of the malleoli, thereby rendering the lower third convex externally. Again, in some cases, there is a marked bow in the femoral shaft, about its middle third. These three curves often co-exist, and together with the muscles they impart to the limb the appearance of a single curve extending from the pelvis to the foot. At times there is one prominent curve; the others, if they exist, are present to such a slight extent that they may escape observation. Often the whole deformity lies beneath the knee-joint.

OSTEOTOMIES FOR THE RELIEF OF GENU VARUM.

This affection being an indefinite quantity, when looked at generally, each case must be considered on its own merits, the surgeon determining at the outset what curves require rectification, and commencing at the most severe he finishes with the least. It is probable that the correction of the greatest curve will so improve the limb that the operator may deem it unnecessary to proceed further. It often happens, however, that the curve which was insignificant in the presence of a greater, speedily becomes prominent when the latter has been effaced. This is all the more striking if the slight curve has not been operated on, and the patient is allowed in due course to walk about. The surgeon is often then sorry that the lesser had not also been operated on. Of course the expedient of operating on the lesser is still open to him; but if he is familiar with the mode of operating, and has gained confidence, it would be well to complete the rectification of the limb at one séance. In this way, in very aggravated cases of bow-legs, ten osteotomies have been performed at once; the femora in one, and the tibiæ and fibulæ at their upper and lower thirds.

The instructions given under the heading of tibial incisions in genu valgum are so far applicable here, and the reader is referred to them. The outer side of the tibia is that which theoretically ought to be divided, and the inner portion snapped. It is, however, easier to divide the inner superficial portion along with the outer margin of the tibia, the back part being divided partly by a horizontal movement from the inner side—guarding well against injuring the muscle. The fibula, unless when it can be bent or snapped, requires division. On operating on the fibula, an osteotome must be used less than the breadth of the bone, otherwise the soft tissues may be injured. When the outer shell of bone has been penetrated, it is not necessary to proceed much further, as the fibula will then easily snap. It is as well to divide the fibula before the tibia, as the former is often so elastic that it gives to the impetus of the mallet. When it does happen to yield in this way, if the osteotome be directed from before backwards, the fibula will be found to be more resistant, and to have much less spring. It is advisable to mark out the shape of the bone from the head downwards, and to fix the finger on it before inserting the scalpel, as the fibula is so narrow and so much covered by soft tissue. When operating on the tibia, and after the bone has been divided, any movement of the limb which tends to open and close the tibial gap, admits air, which often rushes in with a sucking sound; the wound ought therefore to be kept carefully under the spray. In division of the tibia at its lower third, great care must be observed not to injure the soft parts. On performing osteotomy of the femur from the outside for genu varum, the manipulative precautions noticed under the criticism of division of this bone at the lower third for genu valgum, apply, and it would be well to bear them in mind. In dividing the femur higher up, such as at the middle of the shaft, the very

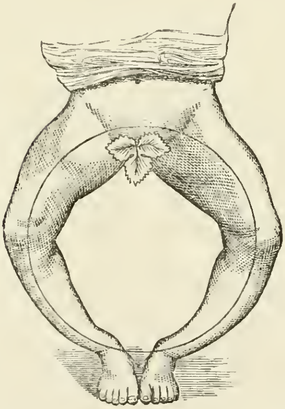

Fig. 40.—Aggravated Case of Genu Varum.

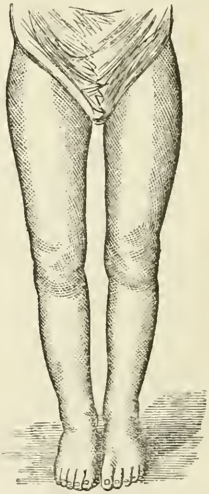

Fig. 41.—The Same—Result after Osteotomy.

dense layer of osseous tisssue will in the adult be found to be very hard and resisting to the osteotome.

Fig. 40 shows a most aggravated case of bow-leg occurring in a patient eighteen years of age, which describes a complete circle. The woodcut is a faithful representation of a photograph of the patient prior to the operation, a circle having been drawn on it at the suggestion of Mr. Miller, the wood engraver. Ten osteotomies were performed at one time. Fig. 41 is the result—the right leg is not quite so straight as the left.

GENU VALGUM AND VARUM COMBINED.

There is nothing peculiar in the mode of dealing with such cases, each limb being operated on according to the principles already laid down. The pelvis must be examined in these cases, as it may be found twisted, but often it is slightly so, and the limbs may be operated on with great benefit to the form of the patient. When they require operation, both limbs ought to be operated on at once. Sometimes the bow-leg does not seem marked enough to

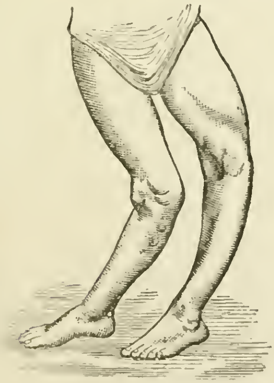

FIG. 42.—CASE OF GENU VALGUM AND VARUM COMBINED.

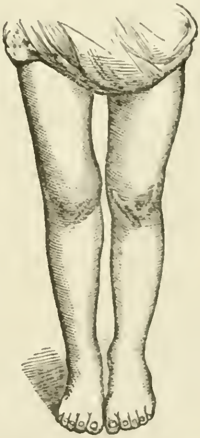

FIG. 43.—RESULT AFTER OSTEOTOMY.

demand operation, especially when compared with the neighbouring knock-knee. If the surgeon should not operate on the bow-leg, in such a case it will appear much more prominent when compared with the neighbouring straightened limb.

ILLUSTRATIVE CASES.

Fig. 42 is a woodcut from a photograph of a patient twenty-one years of age, who was affected with this combination of knock-knee and bow-leg. The internal malleolus was eleven and a half inches from the perpendicular. Supra-condyloid osteotomy was performed on the knock-knee, and four osteotomies were performed on the bow-leg.

Fig. 43 is a woodcut taken from a photograph of the same patient's limbs two months after the operation. In another such case, only more aggravated in form and complicated by a bronchial affection, which had lasted for four or five years, the patient being weak and feeble and only able to go about on crutches in a laboured manner, the operation gave an excellent result. The patient, who was nineteen years of age, could with difficulty, and by the aid of his crutch, walk continuously for ten minutes. Now he walks easily without support, going daily four or five miles to and from his work. He is greatly improved in appearance, and his health, he states, is better than it ever was.

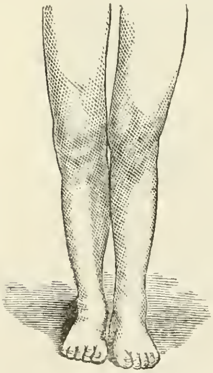

Fig. 44.—Result after Operation for Combined Genu Valgum and Varum.

Fig. 44 is the result in a somewhat similar case to that figured above. The right limb was bent outwards, and the left was affected with knock-knee. He now walks with great ease.

CHAPTER XIX.

ANTERIOR TIBIAL CURVES AND THEIR TREATMENT.

PATHOLOGICAL ANATOMY—SIMPLE OSTEOTOMY AND REMOVAL OF A WEDGE OF BONE—AFTER-TREATMENT.

PATHOLOGICAL ANATOMY.

A CONSIDERABLE number of persons suffer from anterior curves of the tibia. Sometimes these involve the whole tibia, from the foot of the tubercle to the ankle, forming a bow, with the tendo-achillis stretching along its base like a bow-string. More often the lower two-thirds are implicated, and sometimes the lower third is alone affected. In most of these cases the tibia is elongated from before backwards and flattened laterally, the fibula generally participating in this part of the deformity.

SIMPLE OSTEOTOMY.

In these cases the deformity, when slight, may be corrected by a simple osteotomy; that is to say, the division of the bone from before backward, at the most prominent part of the convexity, by an osteotome. But when they are more pronounced, a series of osteotomies, or the removal of a wedge, is necessary to rectify them.

REMOVAL OF A WEDGE OF BONE.

Of the two methods, I am inclined (when a single simple osteotomy is not sufficient) to remove a wedge, as being, on the whole, the most simple and satisfactory. Many have asked an easy method of ascertaining the size of the wedge to be removed, without going into mathematical calculations. One of the easiest methods of ascertaining the size of the wedge to be removed is by turning the limb on its side and taking a tracing of the anterior border of the tibia. Next measuring the breadth of the tibia from before backward at the most prominent part of the convexity, and drawing a second line parallel to the former, corresponding to the breadth measured; then cutting the shape out. After this has been done, fold the paper at the most prominent part of the convexity wedge-fashion, with its base anteriorly, until the pattern has become straight. The base of the wedge will then represent the size of the cuniform portion to be removed. Having ascertained this, it is convenient to have it marked by measuring it by a pair of calipers, keeping their blades fixed at the distance measured, so that they may be applied to the bone when necessary. An incision sufficient to admit the instrument, and, if necessary, the finger, is used, remembering that the skin will slide upwards and downwards to suit. A chisel (not an osteotome) is used. It ought to have a clean cutting edge, with little bevel. It is convenient first to remove a wedge smaller than that required; and then to remove from either side one or two shavings up to the desired extent. In this way opportunity is given for making the incision on each side perfectly smooth. In cutting out the wedge, the periosteum on either side can be preserved; and if so, it gives a surety that the border of the chisel has not injured any of the soft structures. After removing the wedge and seeing that no fragments of bone remain in the opening, the fibula may be attended to. In many cases a simple fracture may be made; but in some, especially when flattened and perhaps elastic, this is not so easy, and it is better to make a subcutaneous osteotomy with the osteotome, after which the limb will become straight by bringing the two anterior cut surfaces into apposition. The tendo-achillis is, in severe cases, a hindrance to the complete straightening of the limb, and when cut the tibial surfaces at once coalesce. In the majority of cases I have not divided the tendo-achillis, but in severe cases it has been necessary, and has been divided accordingly with marked benefit.

Care must be taken, after dividing the bone, not to lacerate or nip the muscles between the osseous surfaces. If any such irritation takes place, suppuration may ensue.

Other tibial curves must be treated on general principles. It will be found that those which are composite—when the limb is twisted, as it were—are much more difficult to deal with, requiring, probably, more than one osteotomy.

AFTER-TREATMENT OF TIBIAL CURVES.

The wounds are dressed as the simple osteotomies are. Sometimes a superficial vein is cut which requires ligature. The wound is left open so that there is no need of introducing a drain. But should the surgeon suspect, from accidental circumstances arising during the operation, that

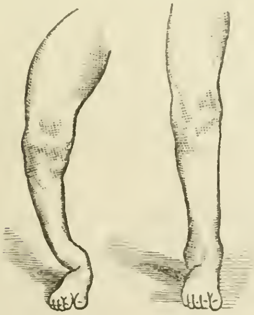

Fig. 45.—Tibial Deformity and Result after Osteotomy (Front View).

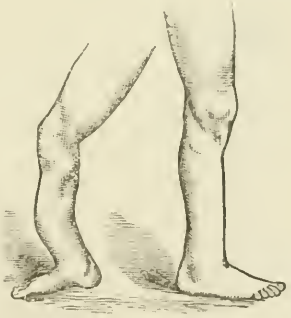

Fig. 46.—Tibial Deformity—Result after Osteotomy (Side View).

suppuration will ensue, care must be taken to have a drain inserted. In only two limbs, from which wedges were removed from the tibia, suppuration followed—but of a trifling amount. In all the others the wounds have healed by organization of the blood-clot, and were found firm at the end of a fortnight; so that they too, as far as the result is concerned, may be looked on as simple fractures when the operation is performed and the treatment carried out antiseptically. The splints are such as may be described as half box, with an abundant padding under the heel.

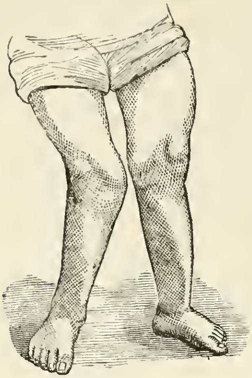

Fig. 47.—Knock-Knee and Tibial Curves (Front View).

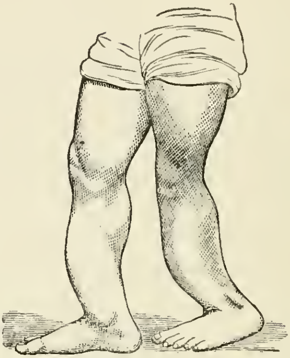

Fig. 48.—Knock-Knee and Tibial Curves (Side View).

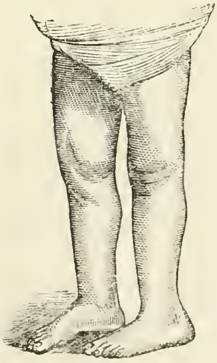

Fig. 49.—Result after Cuniform Osteotomies.

Fig. 45 represents the front view of the right limb of a patient affected with tibial curves, and who was subjected to osteotomy for their relief. The straight limb beside it is the result—also looking from the front. Fig. 46 represents the side view of the same limb prior to operation, while the straight limb is a side view of the result after the operation. In this instance, a wedge of bone was removed with its base anteriorly, and somewhat toward the outer side. The fibula was likewise divided. The healing took place in the ordinary way; no discharge from the wound.

Fig. 47 is a woodcut, taken from a photograph of a patient affected with knock-knee and anterior tibial curves; while Fig. 48 is a side view of the same patient, showing the tibial curves. Fig. 49 is also taken from a photograph of the same patient after operation.

CHAPTER XX.

SPLINTS USED AFTER OSTEOTOMY OF LOWER EXTREMITIES.

GENERAL REMARKS—SPLINT USED AFTER OPERATION FOR GENU VALGUM—SPLINT USED AFTER OPERATION FOR GENU VARUM — SPLINT USED AFTER OPERATION ON TIBIAL CURVES.

GENERAL REMARKS.

There are many different kinds of splints used after osteotomy of the lower extremity, some with extension applied, and some without. There is nothing peculiar about the principles for treating osteotomies other than ordinary fractures. Though they are compound fractures, still with antiseptics they may be safely regarded as simple fractures, and with antiseptic dressings may be treated as such. This, of course, makes a decided difference in the choice of a splint. If these osteotomies were to be regarded as compound fractures, then it would be advisable to put them up in such a way as to enable them to be frequently dressed; probably in paraffin, with windows opposite the wound. As it is, the ordinary fixed splints are applied with the surety that they will in all probability be touched for the first time fourteen days after they have been put on, and they will not again be disturbed until the end of the fourth week. Under such circumstances, the splints used and about to be described answer admirably.

SPLINT USED AFTER OPERATION FOR GENU VALGUM.

The requirements are the maintenance of the limb in a fixed, straight position, and the keeping of the trunk completely at rest. The splints used for genu valgum and varum, and tibial curves are alike in principle, consisting of a back, an outside, and a foot piece; the padding being arranged differently in each case. That used after osteotomy for genu valgum consists of a long splint which reaches from near the axilla to several inches beyond the foot-piece: the portion projecting beyond the foot-piece permits its extremity to be caught firmly in the clamp of a bed-rest, which steadies the whole. There are apertures bored in the long splint, two opposite the pelvis, and two opposite the thorax; these are threaded with bandages which encircle the body. The back piece, which is firmly fixed to the outside splint, extends from about one to two inches below the gluteal fold to the lower third of the tibia, a hiatus being left between this point and the foot-piece, so that the heel will be entirely free from pressure. The breadth of these pieces ought not to be quite that of the diameter of the limb, so that the bandages will catch the limb as well as the splint. There is no peculiarity about the foot-piece (see Fig. 50).

SPLINT USED AFTER OPERATION FOR GENU VARUM.

The splint used after the operation for genu varum is similar to that for genu valgum, with the exception of having a rounded aperture in the outside splint for the reception of the external malleolus.

SPLINT USED AFTER OPERATION ON TIBIAL CURVES.

The splints used for tibial curves must vary according to the special deformity, but the same kind of splint as that used for genu varum is found in many instances serviceable. For anterior curves the back portion is made continuous with the foot-piece, a slight aperture only being left for the heel, as the heel requires in many such cases to be elevated.

Slight extension has sometimes been employed. It is effected by elevating the foot of the bed on blocks, and extending from the foot as it is fixed in the foot-piece; or by perforating the foot-piece on its outer side, and fastening the ordinary extension plaster to the limb. The special padding and manner of fixing the limb to the splint has already been spoken of.

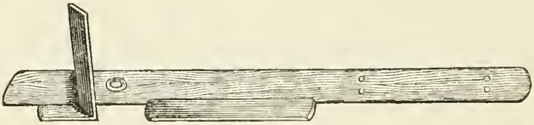

Fig. 50.—Splint used after Osteotomy for Genu Varum.

Fig. 50 is the splint used after osteotomy for genu varum and valgum; in the latter case, however, the opening left opposite the external malleolus shown here is omitted.

CHAPTER XXI.

CLINICAL OBSERVATIONS AND RESULTS OF OSTEOTOMY.

NUMBER OF PATIENTS OPERATED ON AND OSTEOTOMIES PERFORMED—OSTEOTOMIES MADE BY OPEN WOUND AND NOT, IN THE TRUE MEANING, SUBCUTANEOUS—CONSTITUTIONAL STATE OF PATIENTS PRIOR TO OPERATION—EPIDEMIC DISEASES AFTER OPERATION—SUPPURATION AFTER OSTEOTOMY—MORTALITY AFTER OSTEOTOMY — NUMBER OF LIMBS ON WHICH THE SUPRA-CONDYLOID OPERATION HAS BEEN PERFORMED—ORGANIZATION OF BLOOD-CLOT IN OSTEOTOMY WOUNDS.

NUMBER OF PATIENTS OPERATED ON AND OSTEOTOMIES PERFORMED.

Having operated on 557 limbs, belonging to 330 patients, affected with various osseous deformities requiring osteotomy, a few observations on the results may not be without interest. Of the 330 patients, 220 were affected with genu valgum, presenting 367 limbs for treatment. The remaining 110 patients were made up of bow-leg, anterior and other tibial curves, and anchylosis of the hip and knee—in all, 190 limbs. Though 557 limbs were operated on, the number of osteotomies is not thereby indicated, as in many instances more than one operation was performed on one limb. This happened in those cases of genu valgum which were complicated by other curves, such as anterior tibial. In such, the tibia and fibula were divided, besides the femur, making three osteotomies in one limb. In tibial curves of old standing, the tibia and fibula had at times to be divided in two places each, making, in this way, four osteotomies in one limb. Bow-leg, when aggravated, often required the tibia and fibula to be divided in two places, and the femur in one, making, in this way, five osteotomies in one limb, or ten in each patient. So there have been 835 osteotomies performed on these 557 limbs. Both limbs were operated on at once; and, with few exceptions, all the osteotomies necessary for the correction of a deformity, or the deformities, were proceeded with at one sitting, as many as ten having been performed at one time.

OSTEOTOMIES MADE BY OPEN WOUND, AND NOT, IN THE TRUE MEANING, SUBCUTANEOUS.

The wounds leading to the bone were small, but could not, in the true sense of the term, be regarded as subcutaneous, nor were they meant to be so. They enabled the instrument to reach the bone, but as the wounds were generally made longitudinally to the axis of the limb, and as the instrument after introduction was placed transversely, in order to make the osseous division, there was, consequently, an aperture on each side of the osteotome, leading from the external air directly to the interior of the bone. In rectifying anterior tibial curves, wedges were removed by larger wounds than those required for simple osteotomy, the edges of the wounds being held aside by retractors, the purified air having free access to the wound during the whole operation. Not only so, but often, while rectifying such deformities, the air could be heard whistling into the space between the divided osseous surfaces, at the moment of straightening the limb, or in the subsequent manipulation. They are, therefore, compound osseous incisions or fractures treated antiseptically. In one or two peculiar cases, wedges were formed on the opposite side of the limb from that on which the incision in the soft parts was situated; but instead of removing them, they were simply displaced and the limb straightened, the detached portion of bone being left *in situ*. In several other cases the curves were so great that the bones had to be divided in three or four places, the divisions being at very short distances from one another; thus causing what resembled a compound comminuted fracture.

CONSTITUTIONAL STATE OF PATIENTS PRIOR TO OPERATION.

Before considering the results, it is necessary to say a few words on the constitutional state of the patients submitted to operation, as the one might greatly influence the other. At first, those patients were chosen who were healthy and in a good constitutional state. It soon became apparent, however, that if all those who were weak and feeble were to be rejected, the operation would be denied to those in whom it would be of greatest benefit. It was seen that the operation produced little or no reaction in the healthy; the question was, whether it would act in the same way in those whose constitutions were weak. The way was carefully felt at first, experience soon showing that an antiseptic osteotomy could be performed with entire immunity from evil consequences in those who were weak and feeble. It was therefore resolved to operate on all patients presenting themselves, provided their bones were in a suitable condition; that is to say, they were not soft, or in a stage of *ramollissement*. If the patients were too young, they were advised to have the operation postponed. In other respects there was no choice of cases. In many the general health was far from being satisfactory, and was such as would have precluded most operations. The majority were in a low state of health, some attributable to constitutional causes, some to the fact that the deformity rendered progression painful or difficult, and exercise next to impossible. A number were markedly tubercular; one had hæmoptysis for over a year previous to admission, and was still expectorating bloody sputa while in the ward; others were affected with bronchitis, and several had marked spinal affections at various stages. In some, notwithstanding the above-mentioned resolution, their state was so precarious that the operation was almost withheld; but as the persons affected were very desirous to be operated on they were retained, the more so as the refusal to operate on them cut off the only hope they had of being able, in their circumstances, to gain health or to engage in any bread-winning occupation. There were, on the other hand, many who were in good general health, and the deformed limbs were their only drawbacks.

EPIDEMIC DISEASES AFTER OPERATION.

In several instances the patients took acute attacks after the operation. In one, the patient had a smart attack of scarlet fever, complaining of sore throat the evening of the operation day, and the rash appearing on the second day after the operation; so that the osteotomy must have been performed during the stage of incubation. It was a case of typical scarlet fever, passing on to desquamation in due course. Both limbs having been operated on as usual, the wounds were examined with some anxiety, but they behaved quite in the usual way; there was no redness, no blush, and the clot filling up the gap between the lips of the wound vitalized as antiseptic clots do. It is interesting to note that, during the desquamation a portion of the skin bordering the wound became shrivelled up, and on trying to raise it, it peeled off, along with a thin pellicle from the surface of the organized clot, leaving, however, a covering of epithelium underneath. She recovered perfectly in the usual time. Several other patients who had been osteotomized had, at the same time, sore throats, some of them ulcerated, but there were no other symptoms.

SUPPURATION AFTER OSTEOTOMY.

With the exception of eight cases, all the wounds healed by organization of blood-clot without pus-production. In seven of the eight cases which suppurated there was a distinct known cause for the pus-production. Thus, in three instances, a bruising and laceration of the soft parts occurred during the operation. In one, a layer of muscle became caught between the cut surfaces of the tibia, and was severely rubbed during the adjustment of the bone. The fifth and sixth were due to irritation, set up by pressure of a bandage in one and the splint in the other. The seventh may likewise be attributed to pressure of the foot and limb, through the patient's own actions. In the eighth case no clear reason could be assigned for the pus-production. The amount of pus in these cases varied from a few drachms up to a number of ounces, necessitating frequent dressings. With one exception, they ultimately did well, their convalescence not being much retarded. The exception was a bow-legged patient, who, on the second night, during the nurse's temporary absence, rose from bed and fell, his splint and bandages becoming twisted. He managed to get back into bed, and foolishly concealed the accident, though suffering great pain. Ten hours after, at the morning visit, his foot was found twisted, his toes benumbed, and the splint misplaced. A portion of the foot ultimately became gangrenous, and the limb had to be amputated. It was not until long afterwards that the cause of this accident was confessed.

MORTALITY AFTER OSTEOTOMY.

Of those who have been operated on, three died: one from pneumonia, contracted prior to the operation, one from tubercular meningitis, and one from diphtheria.

The first of these was a girl, whose friends stipulated for her that she should be operated on when admitted, as she was desirous to get back to a situation, which had to be kept open for her during a definite time. This stipulation was acceded to. She was seventeen years of age, and when first seen by me she had the aspect of a girl in fair general health. In answer to my inquiries, she stated that she was well, felt strong, was prepared and anxious for the operation. She had a very slight herpetic eruption at the right angle of her mouth, which she attributed to a slight cold. The operation was proceeded with. She took chloroform badly, and several times it had to be temporarily suspended, owing to fits of coughing. On recovering from the anæsthetic she expectorated several rusty-coloured sputa; and on careful examination of her lungs, there was a slight dulness over the left base, accompanied by a vesicular respiratory sound.

She had come from Ireland two days previously, and it now transpired that she had remained on deck of the steamer, and was exposed to cold during the whole of a December night. She had had a feeling of cold and shivering the day previous to the operation. These and some other circumstances which afterwards transpired, had been confessedly withheld by the girl, through fear that the operation might be postponed if they had been made known.

The same day the expectorations continued rusty, the colour deepening toward evening, and the short, catching, pneumonic cough developed, the herpes becoming more pronounced and more extended. In short, the pneumonia developed, passing through its successive stages, the left lung, in its lower and middle lobes, and ultimately the lower lobe of the right, being involved. At the end of two weeks she died from the disease. The wound on the right limb healed by organization of blood-clot, that on the left at first closed, but owing probably to movement caused by the application of poultices to the left side of the chest, it afterwards suppurated, but before death it was again all but closed.

In this case it was evident that she had been operated on just at the outset of what ultimately proved to be severe pneumonia. The herpes on the lips, seen prior to the operation, the respiratory difficulty under chloroform, the rusty sputa transpiring immediately after the operation, the dulness of the left base, the vesicular breathing found at the end of the operation, taken along with the history of the case, all point to the true nature of the disease. Had the operation been postponed for a day or two, as is now usual, after admission, it would not have been performed.

It is improbable that any one could view this in the light of septic pneumonia, as the pneumonic symptoms were present, some before, some detected during, and others immediately after the operation. There is no doubt in my mind that this was a case of pneumonia, pure and simple, which originated previous to the operation, which developed independently of it, and which would have ensued had the operation not been performed.

The second case was that of a lad, nineteen years of age, who was the subject of double knock-knee. He had always been delicate, had often attacks of vomiting, accompanied by symptoms which his medical attendant referred to the head. Two years previous to admission these attacks were so frequent that his recovery had been despaired of. He had, however, been free of them for six months prior to the date of admission to the infirmary. The ordinary operations were performed, and the wounds healed firmly by the tenth day. He had neither pain nor ache from them at any time, and he was considered quite out of danger. On the eleventh day he was much quieter than usual, seemed stupid and confused, and had a restless tossing of the head. His pulse was at times slow, about 50 per minute; some hours after it would become quick and feverish, and again relapse into its former condition. Vomiting set in early and was persistent. His pupils became dilated, the eyes assuming a brilliancy unusual to them. At times there was a squint. On the third day he became slightly delirious, but could be made to answer correctly when his attention was maintained. On the fifteenth day he died. His mother stated, when she first saw him, and subsequently, that this attack was just the same as those he had been subject to; and so satisfied was she and the family that this was the cause of death, that they positively refused to grant a post-mortem. Though no *sectio* was obtained, the Pathologist, Dr. Foulis, and Dr. Clarke, Lecturer on Anatomy, examined the external appearances of the body, and both concluded that the wounds were healed, and that there was nothing in the appearance of the limbs other than normal.

It was evident that this lad died from a head affection, to which he had been more or less subject for many years previously. It is also probable that it was of a tubercular nature, the age not precluding this idea, as there was in the ward at the same time a patient, fifteen years of age, who had been affected with almost identical symptoms, on many previous occasions, though he did not exhibit any of them during the time he was recovering after the operation. It is also quite evident that the wounds had no bearing on the issue; there was no swelling, pain, or redness about the limb, and the wounds were quite healed by the tenth day—previous to the commencement of any head symptoms.

The third case was that of a girl, aged seven years, who had a spinal affection in the cervical region, and also a knock-knee (single). It was operated on in the usual way. Five days after there was a profuse nasal expectoration, and on examining the throat diphtheritic patches were found covering both tonsils and the uvula, which, in spite of treatment, extended into the larynx and trachea, the patient dying through the diphtheritic poison ten days after the date of operation. Fortunately, a post-mortem examination was obtained. Dr. Foulis reports that the diphtheritic membrane extended from the tonsils to near the tracheal bifurcation, and that diphtheria was the cause of death. There was also softening of the cervical vertebræ. A careful examination of the limb was made; the wound was cut out, along with the lower half of the femur and knee-joint.

The accompanying figure is a longitudinal section of the femur and knee-joint in this case. The section is made a little to the outside of the middle line. The difference in thickness between the anterior and posterior borders of the femur is marked, the latter being the concave side, and consequently the thicker. This is seen in most cases of rickets. The epiphysis is marked, and the distance between the seat of incision and the epiphysis is well seen. The wedge opening formed on the inner side of the femur during the operation was obliterated on straightening the limb, so that now the cut osseous surfaces

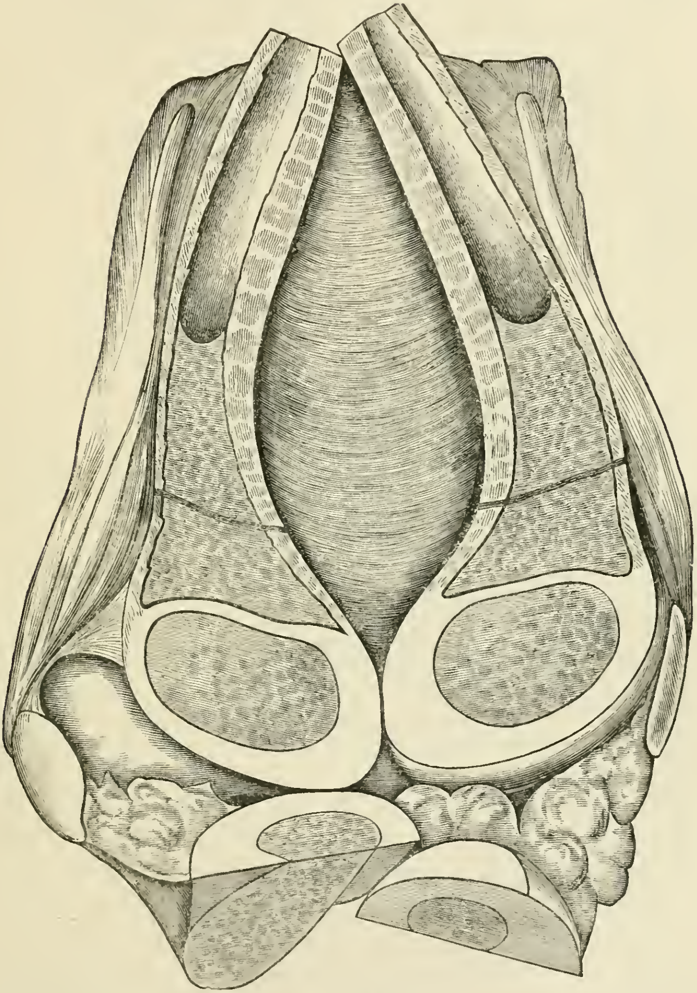

FIG. 51.—LONGITUDINAL SECTION OF FEMUR AND KNEE-JOINT AFTER SUPRA-CONDYLOID OSTEOTOMY FOR GENU VALGUM.

lie in close apposition, as is seen in the figure. The periosteum was found intact all round the bone except at its inner aspect, where it was cut by the osteotome. The external portion of the bone was bent, many of the osseous fibres ruptured, but they still interdigitated. There was a green-stick fracture of the outer part of the femur without an actual hiatus, in the ordinary sense of the term. The knee-joint was in a perfect condition, no effusion, and it is needless to say that the joint-surfaces were in no way implicated.

Dr. Foulis thus describes his examination of the part:—"A small and almost quite healed wound, half an inch long, was seated one inch and a half above the internal condyle of the left femur. In the tissue beneath this wound was a moderate amount of extravasated blood, extending from the edges of the wound deeply along the septa of the tissues; at the wound the blood-clot was brownish red, deeper down it was of a dark red colour. There was no blood beneath the periosteum, which had been divided at the place corresponding to the cutaneous wound and nowhere else: the femur was transversely divided half an inch above the epiphyseal cartilage, and a trace of blood-clot lay between its surfaces. The tissues enclosing the wound were removed *en bloc*, and at once put into absolute alcohol to harden; and as soon as this process was complete, I made a number of razor sections perpendicularly to the skin and transverse to the long diameter of the wound, so that the whole of the wounded area could be studied in successive sections. At both ends of the wound the rete Malpighii and epidermis had already closed it over by a thin layer, which, however, was devoid of papillary indentations, and just beneath this rete Malpighii there was a layer of spindle-celled tissue, below which again lay the blood which had been extravasated at the time of the operation, irregularly disposed along the connective tissue septa. Around this blood, and invading it a little distance, were an enormous number of cells, like granulation cells, forming a sort of casing for the blood;

and in the tissues near it the fibrous septa and the walls of the fat cells were thickly infiltrated with the same sort of cells. In sections across the centre of the wound (Fig. 52), the surface was seen to be covered by a very thin layer of granulation tissue, immediately coating over both blood-clot and fat cells, and here also the infiltration of the blood-clot and the cell-growth amid the surrounding tissue was going on as in the end sections. Under a higher power (Fig. 53), the fat cells were seen lying very superficially sheltered by a delicate coating of the granulation cells, over which the epithelial layer of cells could be seen spreading from the sides. When the edge of the blood-clot was examined under a high power, the red cells of the blood were seen to be quite intact up to near the edge, where they had broken down into granular *débris;* and the granulation cells, which infiltrated the clot and the tissues round it, seemed to be filled with yellow granules resembling the *débris* of the red cells. This was clearly

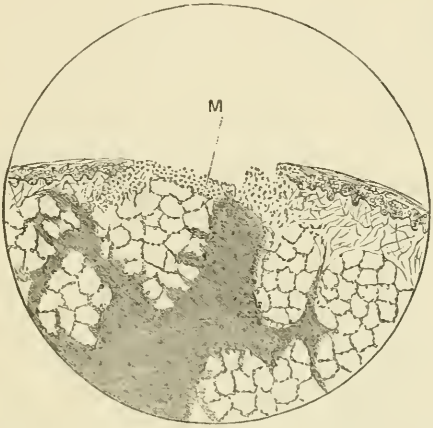

FIG. 52.—SECTION THROUGH CENTRAL PART OF WOUND.

Showing the blood-clot as a shaded mass covered in towards the surface by granulation tissue, and the adipose tissue infiltrated with small cells. The cell-growth at the margin of the clot is indicated rather slightly; it is more abundant than is here shown. (Low power.)

seen, owing to the sections having been tinted with logwood, which failed to alter the yellow colour of the blood cells and *débris*, so that the purple tinted nucleated cells could be seen in and near the edge of the clot full of yellow granular matter. It was evident, from a close study of the clot, that it was gradually wasting away before the advancing cell-growth, and that the invading cells were actually taking up some at least of the *débris* of the clot.

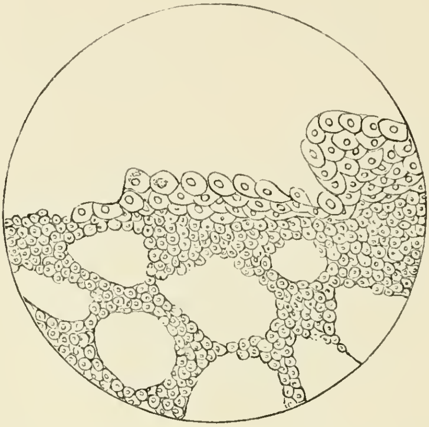

Fig. 53.—View of Part of the Surface of the Wound (at m in Fig. 52).

Showing the granulation tissue with new epithelial cells forming a layer over it. The spaces in the deeper part are the fat cells surrounded by the new cell growth (High power, say 350 diameters).

"I have called these cells granulation cells, for they in no way differ from those seen in antiseptic granulating wounds selected for careful comparison; and whether they were derived from leucocytes, or also, as I think, from a cell-growth in the tissues as well, the picture is still one of a wound healing by granulation, though without suppuration. It would seem that the production of granulations is kept down to the minimun in perfectly antiseptic wounds; the fate of the blood-clot is to be absorbed in a passive manner."

It will be thus seen that though there have been three cases of death *after* the performance of osteotomy, there has been no death *from* osteotomy. After having performed 835 osteotomies on 557 limbs, and not having lost a single patient as a consequent of the operation, it is not too much to claim that antiseptic osteotomy is one of the safest operations in surgery.

When osteotomy is viewed in relation to other methods proposed for the relief of such deformities of the lower extremities, it is seen to be at least quite as safe and much quicker in its action, and a great deal more certain in its results. Besides, these other methods are only applicable to children, their effects being inappreciable when applied to adolescent life, whereas osteotomy has had excellent results in my own hands to over forty years of age. Osteotomy in these removes a deformity, in most cases adds to the height of the patient, and enables him to walk, as a rule, better than he could prior to its performance. Many patients have been carried to the wards by their friends, quite unable to stand unsupported, and have afterwards been able to walk distances, often to fifteen miles at a stretch, without undue fatigue, and to engage in trades which required considerable physical development and strength. As to the question whether the bones grew after the performance of these operations, especially after the osteotomy above the femoral condyles devised for the relief of genu valgum, there is abundant evidence in the affirmative. Many patients have been examined after an interval of several years, and they have been found to have increased in height during that time, and the femora have grown quite proportionately to the rest of the body.

Forty patients who had been operated on for genu valgum, and ten who had been operated on for genu varum, were asked, by post-card, to return to the hospital and show themselves. Forty-five of them presented themselves on a given date, when all of them were found to be able to walk and stand perfectly, and all of them were able to go on their knees with ease. From a short time after their dismissal they had commenced work, and had been actively engaged up to the time when they presented themselves. Among their occupations were the following: Iron moulders, tinsmiths, cloth lappers, bookbinders, letterpress printers, van drivers, tailors, shoemakers, miners, clock makers, umbrella makers, canvassers, clerks, school boys, &c., while on the female side there were dressmakers, milliners, and machinists. Nine of these had walked from thirteen to sixteen miles at a stretch since their operation, six from seven to twelve miles, and three from three to six miles; the remainder, though walking considerable distances, amounting to two or three miles daily, to and from their work, had not yet tried how far they could walk at a stretch. Besides their personal appearance having been greatly enhanced, they had been enabled in many instances since their operation to engage in occupations from which their deformity previously precluded them.

NUMBER OF LIMBS ON WHICH THE SUPRA-CONDYLOID OPERATION HAS BEEN PERFORMED.

Besides the 367 limbs affected with genu valgum operated on by me, there have been over 100 cases of knock-knee operated on by various surgeons in Scotland by my method, with a uniformly good result, as far as has been ascertained. There have been many more cases operated on in England and elsewhere, though I have no data enabling me to estimate their number. Leaving them out of consideration, the number positively known in which the supra-condyloid operation has been performed for the relief of genu valgum is 470. It is also satisfactory to learn from several surgeons who have operated in various ways for the relief of genu valgum, that when once they had operated by the supra-condyloid method they renounced the other method in its favour.

ORGANIZATION OF BLOOD-CLOT IN OSTEOTOMY WOUNDS.

Many surgeons doubt that blood-clot undergoes organization in a wound. As this term has been used, one or two remarks are necessary. Regarding the wound from a clinical aspect, there can be little dubiety about the fact that the process of healing is different from healing by "granulations," in the ordinary sense of this term.

The ordinary course which a wound healing by blood-clot takes, may be described as follows. The blood is effused between the lips of the wound and forms a clot. During the first few days a layer of translucent yellowish material is often effused from the surface of the clot: this, however, is not constant. During the first week the blood-clot remains soft and moist, then it becomes opaque round the margins, and by-and-by it dries, the opacity and dryness gradually extending centripetally. When dried, it shrivels up and peels off, exposing a layer of epidermis. When the wound is kept covered for eight or ten days, and looked at then for the first time, the delicate layer of epithelium is at times almost transparent, and one sees what appears to be a yellowish red mass beyond; unfortunately, a few minutes' exposure to the light and spray is sufficient to render the epithelium opaque, and so the light and the eye are excluded. If the cellular tissue be left protruding from the wound so as to come into direct contact with the protective plaster, the ordinary process of what is known clinically "as healing by granulation" occurs, most likely accompanied by pus-production. If one permits a few points of cellular tissue to protrude, while the rest of the gap is filled by blood-clot, one finds that, in eight or ten days, the blood-clot has been covered by epithelium, while granulation islands are found at the points where the cellular tissue protruded. These islands will probably bleed while removing the dressing, and will require to be reduced to the level of the surrounding parts before being covered by epithelium. On the other hand, if the cellular tissue is removed, so as to leave a little pit between the lips of the wound, and this pit be filled with blood-clot, the epithelium covers that interspace between the lips of the wound, receiving support and nutriment from the underlying blood-clot, or the material into which it has been converted. Where a little pressure is exercised over the wound by means of an internal dressing, so as to prevent the blood from going beyond the lips of the wound, and in this way bringing the blood-clot up just to the level of the skin, the epidermis will commence to proliferate, and cover this level blood-clot in a very short time. When the blood-clot is protruding beyond the level of the skin, the epithelium seems to develop and extend on the level of the skin, thus cutting off the superficial layer of blood-clot, in the same way as a piece of catgut (carbolized) is cut across at the level of the skin, the portion inside being retained, that outside being rejected. Healing by aseptic blood-clot then presents the following peculiarities. The wound heals without presenting at any time a raw surface. There is consequently no pus-production, and little, if any, discharge of any kind. The epidermis covers over the surface of this clot as it becomes organized. These changes do not take place at haphazard, or only now and again; if the wound is aseptic, and other causes of irritation are removed, they take place with a uniformity that may be relied on. Lister has pointed out another peculiarity, that the cicatrix thus formed has not the same tendency to contract that granulations have. Lister, at the time he wrote, had not had an opportunity of examining the histological characters of the blood-clot organization. The case quoted, of the osteotomy wound, is the first opportunity which was given me of examining such, and it will be seen that Dr. Foulis thus describes the histological appearances as granulation tissue, and, by way of explanation, states — "I have called these cells granulation cells, for they in no way differ from those seen in antiseptic granulating wounds selected for careful comparison; and whether they were derived from leucocytes, or also, as I think, from a cell-growth in the tissues as well, the picture is still one of a wound healing by granulations, though without suppuration. It would seem that the production of granulations is kept down to the minimum in perfectly antiseptic wounds; the fate of the blood-clot is to be absorbed in a passive manner." Whatever may be the histological characters found on extended observation of organized blood-clot, there can be no doubt that the blood-clot forms a medium whereby the epithelium covers an open wound more quickly than by any other method of healing; and therefore healing of an open wound by organization of blood-clot is the safest, quickest, and best.

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